Appendix G Glossary and Explanation of Key Terms

G.0 SUMMARY

This appendix lists and explains key terms used in the *Energy Efficiency Standards* (standards or EES) for low-rise residential buildings. Part G.1 introduces the structure of the appendix. Part G.2 is a list of all terms defined in the appendix. Part G.3 defines and explains all of the terms listed in Part G.2. Finally, Part G.4 reprints all of the tables used throughout the appendix for easy reference.

G.1 INTRODUCTION

The standards use a variety of terms relating to building attributes, features and devices; building energy conservation; energy efficiency and the calculations required for submittal to the local enforcement agency. The purpose of this chapter is to define and explain relevant terms in the context of the standards for low-rise residential buildings. This *Glossary and Explanation of Key Terms* provides specific information as to how each term is applied to compliance with any of the compliance paths: prescriptive packages or computer performance. Clarifications and definitions unique to particular compliance paths are contained in Chapters 3 and 4.

For certain topics, the text provides a cross reference to other parts of the manual, as well as to other Energy Commission publications and notices. Any direct quote from another source "is indicated with quotation marks like this." The name of the source may be listed in brackets at the end of the quote like this [*EES*, Section 101]

AER refers to the *Appliance Efficiency Regulations*, September 1992.

CHAPTER OVERVIEW

Applicable sections of the California Code of Regulations, Title 24, Part 6, Sections 100 through 118 and 150 through 152.

EES refers to the *Energy Efficiency Standards,* 1998 edition, unless otherwise noted.

UBC refers to the State adopted *International Conference of Building Officials Uniform Building Code,* 1994 edition or the year indicated.

G.2 LIST OF TERMS

ACCA
Accessible
Addition
AFUE (Annual Fuel Utilization Efficiency)
Air Conditioner
Air Porosity
Air-to-Air Heat Exchanger
Alteration
Alternative Calculation Method (ACM)
Alternative Component Packages
ANSI (American National Standards Institute)
Appliance Efficiency Regulations (AER)

Approved by the Commission
Approved Calculation Method (see Alternative Calculation Method)
Areal Heat Capacity
ARI (Air-Conditioning and Refrigeration Institute)
ASHRAE (American Society of Heating, Refrigeration, and Air-conditioning Engineers)
ASHRAE Handbook of Fundamentals
ASME (American Society of Mechanical Engineers)
ASTM (American Society for Testing and Materials)
Atrium (see 101(b))
Automatic
Back
Btu/hr
Building
Building Envelope
Building Location Data
Building Types
Certifying Organization
Climate Zone
Coefficient of Performance, Cooling (COP)
Coefficient of Performance, Heating (COP)
Combined Hydronic Space/Water Heating
Commission (see Energy Commission)
Compliance Documentation
Conditioned Floor Area (CFA)
Conditioned Footprint Area
Conditioned Space
Conditioned Volume
Controlled Ventilation Crawl Space (CVC)
Converting Efficiencies
Cooling Equipment
Cooling Load
Cooling Load Temperature Difference (CLTD)
Covered Product
Crawl Space
Custom Energy Budget
Decorative Gas Appliance
Degree Day, Heating
Design Conditions
Design Heat Gain
Design Heat Loss
Directly Conditioned Space
Directory of Certified Water
Dominant Occupancy
Door
East-Facing
EER (Energy Efficiency Ratio)
Efficacy
Electric Resistance Heating
Enclosed Space
Energy Budget
Energy Commission
Energy Efficiency Standards (Standards)
Energy Factor (EF)
Energy Obtained from Depletable Sources
Energy Obtained from Nondepletable Sources
Enforcing Agency
Evaporative Cooler
Exceptional Method
Exfiltration
Exposed Thermal Mass
Exterior Door
Exterior Floor/Soffit
Exterior Partition
Exterior Roof/Ceiling
Exterior Wall
Exterior Wall Area
Fenestration Area (Glazing Area)
Fenestration Product
Fireplace
Floor Area
Footprint Area
Fossil Fuels
Framed Partition or Assembly
Framing Effects
Front
Gas Heating System
Gas Log
General Lighting
Geothermal Heat Pump
Glazing
Governmental Agency
Gross Exterior Roof Area
Gross Exterior Wall Area
Ground Floor Area
Ground Source Heat Pump
Habitable Story
Heat Capacity (HC)
Heat Pump
Heating Equipment
Heating, Ventilating and Air Conditioning (HVAC)
HI (Hydronic Institute)
High-Rise Residential
Hotel/Motel
HSPF (Heating Seasonal Performance Factor)
HVAC
Hydronic Space Heating
Indirectly Conditioned Space
Infiltration
Infiltration Controls
Insulation
Insulation R-value
Interior Partition
Left
Lighting

Low-Rise Residential
Lumens/Watt
Luminaire
Manufactured Device
Mechanical Cooling
Mechanical Heating
Mixed Occupancy
Multi-Family
NFRC (National Fenestration Rating Council)
North-Facing
Operable Shading Device
Outside Air
Proposed Design
Radiant Barriers
Raised Floor
Readily Accessible
Rear
Recovered Energy
Recovery Efficiency
Relative Solar Heat Gain
Repair
Right
Roof
R-Value (Thermal Resistance)
SEER (Seasonal Energy Efficiency Ratio)
Service Water Heating
Shading
Shading Coefficient (SC)
Side Fins
Single Family Attached
Single Family Building
Skylight
Slab-on-Grade
SMACNA (Sheet Metal and Air-conditioining Contractors National Association)
Solar Heat Gain Coefficient (SHGC)
Source Energy
South-Facing
Spa
Space Conditioning System
Stairs
Standard Design
Standards
Standby Loss
Subordinate Occupancy
System
Task Lighting
Thermal Mass
Title 24
UBC (Uniform Building Code)
UL (Underwriters Laboratory)
UMC (Uniform Mechanical Code)
Unconditioned Space
Unit Interior Mass Capacity (UIMC)
U-Value
Vapor Barrier
Ventilation Air
Weatherstripping
Weighted Averaging
West-Facing
Window Area
Wood Heater
Zonal Control
Zone, Space Conditioning

G.3 DEFINITIONS AND EXPLANATIONS OF KEY TERMS

ACCA

Air-Conditioning Contractors of America.

Accessible

“[H]aving access thereto, but which first may require removal or opening of access panels, doors, or similar obstructions.” [*EES*, Section 101] (see also *Readily Accessible).*

Additions

An addition is an an extension or increase in the conditioned floor area and volume of a building. This includes converting an existing unconditioned space to a conditioned space, such as remodeling a basement, garage or attic. The standards require energy compliance analysis and documentation for all additions that increase the conditioned space and volume of the building. Chapter 7 includes detailed discussion of energy compliance for additions. See also *Alteration, Building Type, Conditioned Space and Conditioned Floor Area.*

AFUE (Annual Fuel Utilization Efficiency)

The AFUE or Annual Fuel Utilization Efficiency of a space heater is the "measure of the percentage of heat from the combustion of gas or oil which is transferred to the space being heated during a year, as determined using the applicable test method in the Appliance Efficiency Regulations or 112." [*EES*, Section 101]

AFUE is similar to the thermal efficiency in that it does not include energy consumption from standby wattage and fans.

The *Appliance Efficiency Regulations* require that AFUE of all new central furnaces manufactured on or after January 1, 1992 be at least 78 percent for equipment with output capacity less than 225,000 Btu/hr. Central furnaces with outputs greater than or equal to 225,000 Btu/hr are rated according to their Steady State (or Thermal) Efficiency. Other space heating equipment manufactured on or after January 1, 1994 has the following AFUE requirements:

Appliance	*Capacity*	*AFUE*
Furnace		78%
Gas Steam Boilers	Up to 300,000 Btuh	75%
Other Boilers	Up to 300,000 Btuh	80%

Gas space heaters manufactured on or after January 1, 1990 shall be certified to have AFUE values greater than or equal to those listed in Table G-1 below:

Table G-1 - Non-Ducted, Non-Central Gas-Fired Heating Equipment

Gas Fired Wall Furnaces, Floor Furnaces and Room Heaters			*AFUE*
Wall	fan type	up to 42,000 Btu/hour	73%
		over 42,000 Btu/hour	74%
	gravity type	up to 10,000 Btu/hour	59%
		over 10,000 Btu/hour up to 12,000 Btu/hour	60%
		over 12,000 Btu/hour up to 15,000 Btu/hour	61%
		over 15,000 Btu/hour up to 19,000 Btu/hour	62%
		over 19,000 Btu/hour up to 27,000 Btu/hour	63%
		over 27,000 Btu/hour up to 46,000 Btu/hour	64%
		over 46,000 Btu/hour	65%
Floor		up to 37,000 Btu/hour	56%
		over 37,000 Btu/hour	57%
Room		up to 18,000 Btu/hour	57%
		over 18,000 Btu/hour up to 20,000 Btu/hour	58%
		over 20,000 Btu/hour up to 27,000 Btu/hour	63%
		over 27,000 Btu/hour up to 46,000 Btu/hour	64%
		over 46,000 Btu/hour	65%

The AFUE of mobile home furnaces manufactured on or after September 1, 1990 shall be certified not to be less than 75 percent.

See *Heating, Ventilating and Air Conditioning.*

Air Conditioner

Central air conditioners with output less than 65,000 Btuh are rated according to their Seasonal Energy Efficiency Ratio (SEER), the total cooling output of a central air conditioner in Btu during its normal usage period for cooling divided by the total electric energy input in watt-hours during the same period.

The SEER takes into account losses such as electricity for fan power and cycling on and off. The SEER is generally higher than the EER, since it takes into account seasonal performance over a 12 month period.

The SEER is a function of both the condensing unit (compressor) and the type of coil selected to be used with it. Equipment manufacturers typically list efficiencies only of certain

compressor-coil combinations. Only the SEER rating determined from the compressor in combination with the largest selling national coil may be used for compliance with the building energy efficiency standards.

Central air conditioners with outputs of 65,000 Btuh or more are rated using an EER. See above *efficiency conversions* for equipment not tested for an SEER.

See *SEER* and *EER* for the required efficiency levels for various types of air conditioners and heat pumps.

Air Porosity

Air porosity is a measure of the air-tightness of infiltration barriers in units of cubic feet per hour per square foot per inch of mercury pressure difference.

Air-to-Air Heat Exchanger

An air-to-air heat exchanger is a device that reduces heat loss or gain that occurs when a building is mechanically vented. It accomplishes this by transferring heat between the conditioned air being exhausted and the unconditioned air being supplied.

Alteration

An alteration is “any change to a building's water heating system, space conditioning system lighting system, or envelope that is not an addition.” [*EES*, Section 101]

Alternative Calculation Method (ACM)

An alternative calculation method is one of “the Commission's Public Domain Computer Programs, one of the Commission's Simplified Calculation Methods, or any other calculation method approved by the Commission."[*EES*, Section 101]

Alternative Component Packages

An alternative component package is one of the sets of prescriptive requirements contained in Section 151(f) and Tables 1-Z1 through 1-Z16 of the standards (Chapter 3) which a building may meet to achieve compliance with the standards. These are often referred to as the prescriptive packages or packages.

"Buildings that comply with the prescriptive standards shall be designed, constructed and equipped to meet all of the requirements of one of the alternative packages of components shown in Tables 1-Z1 through 1-Z16 for the appropriate climate zone..." [*EES*, Section 101]

See also Chapter 3, Figures 3-1 through 3-5.

ANSI

American National Standards Institute.

Appliance Efficiency Regulations

"Appliance efficiency regulations are the regulations [standards] in Title 20, sections 1601 et. seq. of the California Code of regulations Title 24 California Code of Regulations." [*EES*, Section 101]

The *Appliance Efficiency Regulations* regulate the minimum efficiency of certain appliances, such as heating and cooling equipment, sold in California.

Approved by the Commission

"Approved by the Commission means approval under 25402.1 of the Public Resources Code." [*EES*, Section 101].

Approved Calculation Method

See *Alternative Calculation Method*.

Areal Heat Capacity

Areal heat capacity is the amount of heat, in Btu, that can be stored per square foot of wall assembly by raising the average temperature of the wall assembly one degree Fahrenheit.

See *Heat Capacity.*

ARI

Air-Conditioning and Refrigeration Institute.

ASHRAE

American Society of Heating, Refrigerating and Air-Conditioning Engineers.

ASHRAE Handbook of Fundamentals

A reference book published by the American Society of Heating, Refrigerating and Air-Conditioning Engineers which includes industry accepted standard information on thermal properties of materials and HVAC system sizing. The standards reference the 1993 edition.

ASME

American Society of Mechanical Engineers.

ASTM

American Society for Testing and Materials.

Back

"Back" indicates the back side of the building as one faces the front facade from the outside (see *Front*). This designation is used on the Certificate of Compliance (CF-1R form) to indicate the orientation of fenestration (e.g., Back-West). See also *East-Facing, South-Facing*, etc.

Btu/hr (Btuh)

British thermal unit per hour, also abbreviated Btuh. One Btu equals the amount of heat needed to raise the temperature of one pound of water one degree Fahrenheit. Used for measuring heating and cooling equipment output.

Building Envelope

The Building Envelope is made up of the elements of a building that enclose conditioned spaces and through which thermal energy may be transferred to or from the exterior.

Building Location Data

Building location data refers to specific outdoor design conditions used in calculating heating and cooling loads. Different from the climate zone used for compliance (see *Climate Zone* below), design data includes the typically warmest and coolest outdoor temperatures that a building is likely to experience in an average year in its particular location.

Temperatures are from the ASHRAE publication, *SPCDX, Climatic Data for Region X - Arizona, California, Hawaii, Nevada,* May 1982 edition (see Appendix C). For heating, the outdoor design temperature is the Winter Median of Extremes. A higher temperature is permitted, but no lower than this value. For cooling, the outdoor design temperatures must be the 0.5 percent Summer Design Dry Bulb and the 0.5 percent Wet Bulb columns.

If a building location is not listed, the local enforcement agency may determine the location for which data is available that is closest in its design characteristics to the actual building site.

Building Types

Building type refers to the classification of residential buildings defined by the *UBC* and applicable to the requirements of the *Energy Efficiency Standards.* This manual is concerned with the energy standards that apply to all new low-rise residential buildings, which includes all single family dwellings and multi-family buildings with three or fewer habitable stories in the entire building. This manual does not consider standards applicable to multi-family buildings with four or more habitable stories in the entire building, hotels, motels and officially designated historical buildings. A multi-family building contains multiple dwelling units that share common walls (single family attached) and may also share common floors or ceilings.

All new residential buildings not in the above low-rise category are covered in the 1998 edition of Energy Commission's *Nonresidential Manual for Compliance with Energy Efficiency Standards* (see Parts 1.1 and 1.2).

A single-family building is a single dwelling unit of occupancy group R-3, as defined in the *UBC***,** which stands separate and unattached from other dwelling units but may have an attached garage.

A multi-family building is a dwelling unit of occupancy group R, as defined in the *UBC***,** that shares a common wall and/or floor/ceiling with at least one other dwelling unit. See Chapter 7, Part 7.1 for more information on

multi-family energy compliance. A single family attached building is a dwelling unit of occupancy group R that shares a common wall with another dwelling unit.

An addition is an extension of or increase in conditioned floor area and volume of a building, which can be new construction or adding space conditioning to an existing space. See Chapter 6 for more information on energy compliance of additions.

An existing building is:

> "...a building erected prior to the adoption of [the current] code, or one for which a legal building permit has been issued." [*UBC,* Part II, Section 403]

Climate Zone

The Energy Commission established 16 climate zones that represent a geographic area for which an energy budget is established. These energy budgets are the basis for the standards.

Figure G-1 is an overall map of the 16 climate zones. Appendix E contains a listing of the climate zone for most California citieis. The Energy Commission publication *California Climate Zone Descriptions* (P400-95-041, July 1995) includes the same "Master Climate Zone Location Listing" for each city and the detailed climate zone boundary descriptions.

The Energy Commission originally developed weather data for each climate zone by using unmodified (but error-screened) data for a representative city and weather year (representative months from various years). The Energy Commission analyzed weather data from weather stations selected for (1) reliability of data, (2) currency of data, (3) proximity to population centers, and (4) non-duplication of stations within a climate zone. Using this information, they created representative temperature data for each zone. The remainder of the weather data for each zone is still that of the representative city. The representative city for each climate zone (CZ) is as follows:

CZ1: Arcata	CZ9: Pasadena
CZ2: Santa Rosa	CZ10: Riverside
CZ3: Oakland	CZ11: Red Bluff
CZ4: Sunnyvale	CZ12: Sacramento
CZ5: Santa Maria	CZ13: Fresno
CZ6: Los Angeles (AP)	CZ14: China Lake
CZ7: San Diego	CZ15: El Centro
CZ8: El Toro	CZ16: Mount Shasta

Combined Hydronic Space/Water Heating

A combined hydronic space conditioning and water heating system is one in which both domestic hot water and space heating is supplied from the same water heating equipment. Combined hydronic space heating includes both radiant floor systems and convective or fan coil systems. The method for analyzing combined hydronic space and water heating systems is explained in Chapter 6, Part 6.5 and Chapter 8, Part 8.9.

Commission

California Energy Commission, also known as the State Energy Resources Conservation and Development Commission. The Energy Commission was established by the Warren-Alquist Act contained in the Public Resources Code. Its mandate, in part, is to develop and implement building energy efficiency standards as described in this manual. See also Chapter 1, Part 1.1.

Compliance Documentation

There are several forms used to demonstrate compliance with the standards that are recommended for submittal to the local enforcement agency. Table G-2 contains a list of these forms. A copy of each recommended form is contained in Appendix A of this manual. Similar forms, such as those produced by approved computer programs, are also allowed to be used for compliance submittals as long as the information is the same and the format is similar [EES, Section 10-103(a)(2)(C)]. In addition to the forms described below, additional information must accompany the compliance documentation:

Plans and Specifications

Plans and specifications showing the characteristics of each feature, material, component, and manufactured device proposed to be installed in order to have the building meet the requirements of the standards. If any characteristic

is materially changed before final construction and installation and there is any question that the building might no longer comply with the standards, the building must be brought back into compliance and amended plans, specifications, and Certificate(s) of Compliance must be submitted to the enforcement agency. [*EES*, Section 10-103(a)(2)(B)]

Heating and Cooling Load Calculations

Load calculations are performed as described in Chapter 2, Part 2.4 under Space Conditioning Equipment Sizing. They need not be submitted unless requested by the local building department.

The ***forms*** are summarized below:

Certificate of Compliance: Residential (CF-1R)

A Certificate of Compliance summarizing all conservation features and devices required for energy compliance of the residential building must be submitted, regardless of the compliance approach. This form must be signed by the designer or person responsible for construction and the building owner (see Chapter 1, Part 1.3). The CF-1R must be included "on" the building plans (*EES*, Sec 10-103(a)(2)(A)).

Mandatory Measures Checklist (MF-1R)

This checklist is used by the building plan checker and field inspector to verify compliance of the building with the prescribed list of mandatory features, equipment efficiencies and product certification requirements. The documentation author indicates compliance by initialing, checking, or marking N/A (for features not applicable) in the boxes or spaces provided for the designer.

Computer Method (C-2R)

If a computer performance method is used for compliance, a detailed input report or C-2R form is generated by the approved program summarizing the input assumptions used in the analysis of the building. Approved computer programs automatically generate all required forms (see Chapter 5, Part 5.5).

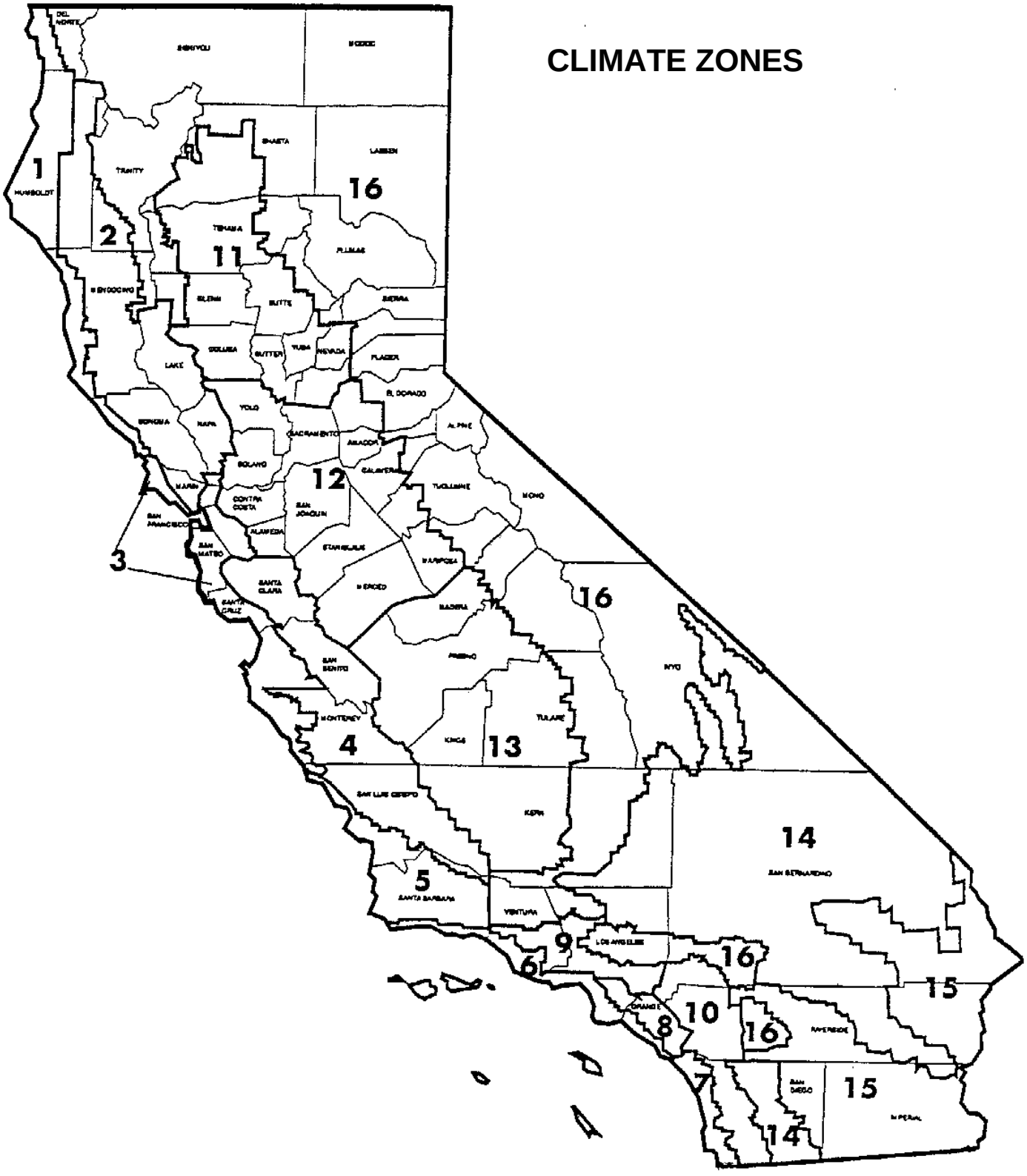


Figure G-1. California Climate Zones

No equivalent form is needed for compliance with a prescriptive package (see Chapter 3, Part 3.3).

Table G-2: Typical Compliance Forms Needed for Each Compliance Path

Form	Prescriptive Package	Computer Method
CF-1R	Req	Req
MF-1R	Req	Req
C-2R	NA	Req
WS-1R	If App.	NA
WS-2R	If App.	NA
Form 3R	If App.	If App.
Water Heating[3]	If App.	NA
Form S	If App.	If App.
Load Calc.[4]	If App.	If App.
IC-1	Req	Req
CF-4R	NA	If App.
CF-6R	Req	Req

KEY: If App. = If Applicable, Req = Required information, NA = Not Applicable

3 Required for all non-standard water heating systems as defined in Chapter 5, except for Prescriptive Package compliance analyses with water heating systems listed in Table 3-4. Calculations may be on the worksheets which accompany the water heating method (see Chapter 6, Part 6.3). Water heating calculations are automatically included in the approved computer methods so no additional water heating forms are required for those compliance paths.

4 Load calculations must be performed, but need not be submitted unless requested by the local building department.

Proposed Construction Assembly (Form 3R)

A proposed construction assembly (Form 3R) need *not* be submitted for:

- Prescriptive compliance, if the insulation R-value meets or exceeds the package requirement and the frame type is wood; or
- The computer performance method, if the standard default U-values from Table 4-1 for particular levels of insulation are assumed.

See *R-value* for instructions on completing Form 3R.

Water Heating Calculations

Water heating calculations are *not* required for the following water heating systems:

(1) Non-recirculating gas type heater with a storage tank of 50 gallons or less that meets the minimum appliance standards, and for any water heater with an energy factor of less than 0.58 includes an R-12 external insulation wrap; or

(2) Prescriptive Package compliance analyses with water heating systems listed as a "Y" in Table 3-4; or

(4) Compliance analyses with approved computer methods (these programs automatically perform all required water heating calculations internally).

See Chapter 6 for complete instructions on the water heating method.

Solar Heat Gain Coefficient Worksheet (Form S)

Documentation of solar heat gain coefficient calculations. Form S is not required to document solar heat gain coefficients taken from Tables G-6 and G-8.

Thermal Mass Worksheet (WS-1R)

A worksheet to document (1) the thermal mass goal of Alternative Component Packages A and C and (2) the building's interior thermal mass to gain compliance.

Weighted Average Worksheet (WS-2R)

A worksheet documenting how weighted average values are calculated in the following instances:

- With a package, when two or more treatments (such as different opaque wall assemblies) are averaged to meet a requirement; or

- With a computer performance method, when several values are averaged together to input into a program (such as multiple HVAC efficiencies in a multi-family building). Typically, however, each feature would be input into the computer program separately, and the program would perform all area-weighted averaging internally, with no additional form required.

Insulation Certificate (IC-1)

This form must be completed by the insulation installer or general contractor.

Certificate of Field Verification and Diagnostic Testing (CF-4R)

This certificate is completed by a HERS rater for each home that uses performance (computer) compliance credits that require diagnostic testing and field verification by a HERS rater such as improved duct efficiency or reduced envelope leakage.

The requirements for this certificate and the information on this form are spelled out in detail in Chapter 4.

Installation Certificate (CF-6R)

An installation certificate must be completed by the installer of each manufactured device (i.e., appliances and fenestration products) or by the general contractor for all devices regulated by the *Appliance Efficiency Regulations*, or the standards.

This form must either be posted at the job site or made available to the inspector. When completed, a copy of this form must also be provided to the first occupant of the building. See Chapter 1 for additional information about this form.

This manual includes the recommended version of the Installation Certificate for residential buildings. This particular form is not required, but the information it includes must be on any alternate version.

Conditioned Floor Area (CFA)

Conditioned floor area (CFA) is the [total] floor area (in square feet) of enclosed conditioned space on all floors of a building, as measured at the floor level of the exterior surfaces of exterior walls enclosing the conditioned space. [*EES*, Section 101]

This term is also referred to in the standards simply as the floor area.

This is an important value for the purpose of compliance since annual energy use is divided by this value to obtain the energy budget. In the prescriptive packages, fenestration area is expressed as a percentage of this value.

CFA is calculated from the plan dimensions of the building including the floor area of all conditioned and indirectly conditioned space on all floors (see definition of *Indirectly Conditioned Space*). It includes lofts and mezzanines but does not include covered walkways, open roofed-over areas, porches, pipe trenches, exterior terraces or steps, chimneys, roof overhangs or parking garages. Unheated basements or closets for central gas forced air furnaces are also not included unless shown to be indirectly conditioned.

Stairs

The floor area of an interior stairway is determined as the CFA beneath the stairs and the tread area of the stairs themselves.

See Figure G-2 for an example of total CFA.

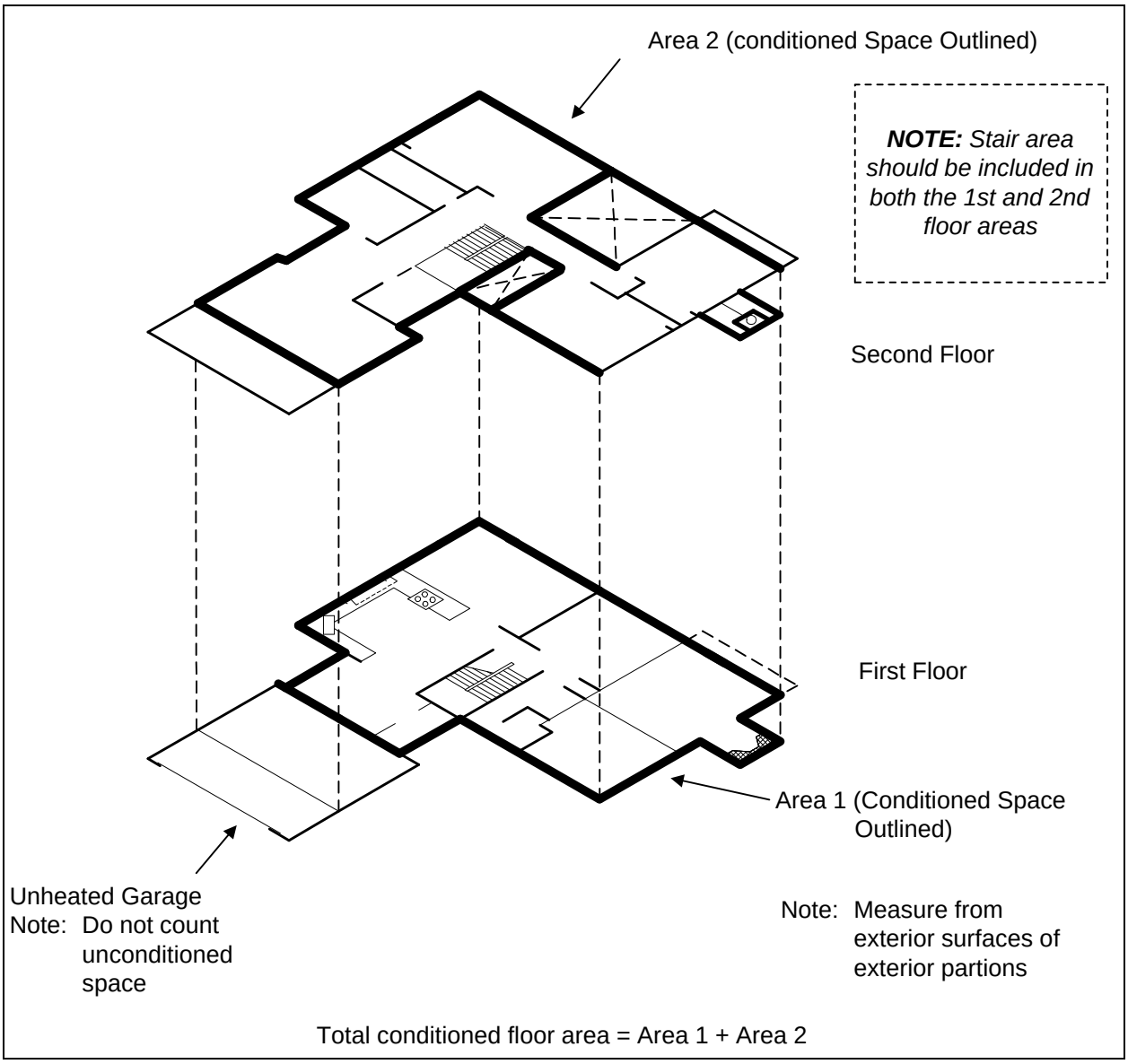


Figure G-2: Total Conditioned Floor Area

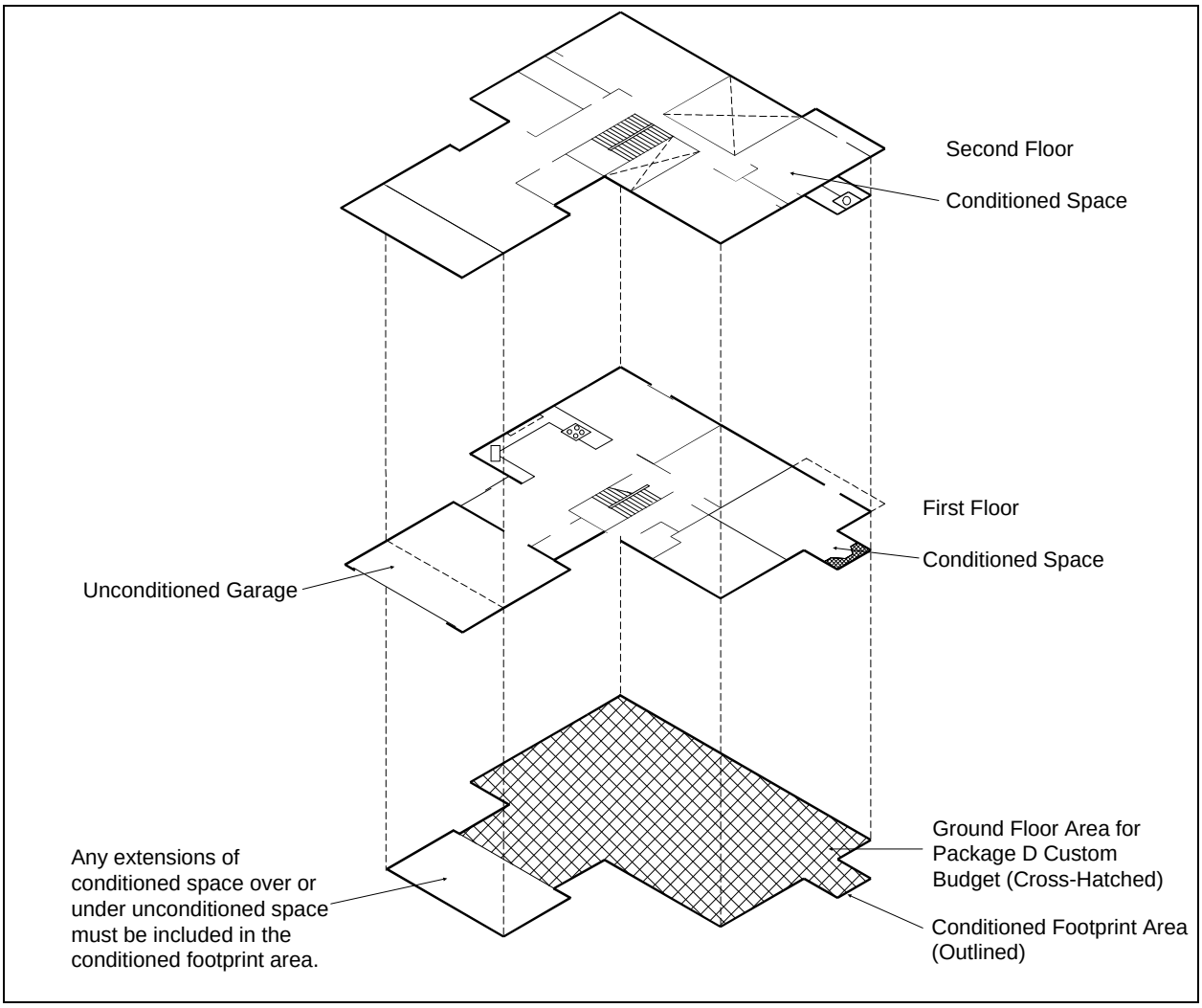


Figure G-3: Conditioned Footprint Area

Conditioned Footprint Area

The conditioned footprint is the total area of the building footprint, in square feet, not including unconditioned space.

The conditioned footprint area may be equal to the first floor area, or it may be greater. The footprint area is the total area of floor over unconditioned space (not over conditioned space), ambient air and slab-on-grade.

One way to think of the conditioned footprint area is as the area of the largest conditioned floor in the building plus the conditioned floor area of any projections from other stories that extend beyond the outline of that largest floor.

See Figure G-3 for an example of conditioned footprint area.

See also *Ground Floor Area, Raised Floor* and *Slab-on-Grade*.

Conditioned Space

In residential compliance, conditioned space is space in a building that is either directly conditioned or indirectly conditioned. [*EES*, Section 101]

Controlled Ventilation Crawl Space (CVC)

The Energy Commission has approved an exceptional method for analyzing the energy impact of buildings with raised floors which use foundation wall insulation and have automatically controlled crawl space vents. The method is available as an option using an approved computer method with unique modeling criteria explained in Chapter 5, Part 5.4L, following installation guidelines found in Chapter 8, Part 8.7.

Converting Efficiencies

When equipment is not tested for SEER, the EER may be used as the SEER. When heat pump equipment is not tested for HSPF, the following conversions may be assumed:

- Through-the-wall heat pump = 6.6 HSPF
- Central air conditioning heat pumps that do not have an HSPF rating for heating but have a COP rating, HSPF = (3.2 x COP) - 2.4

Cooling Load

The rate at which heat must be extracted from a space to maintain a desired room condition.

Cooling Load Temperature Difference (CLTD)

An equivalent temperature difference used for calculating the instantaneous external cooling loads across a wall or roof (CLTD = External Cooling Load/(U-Value x Area)). When used for glass, the CLTD calculates only the conduction cooling load.

Coefficient of Performance, Cooling (COP)

The coefficient of performance for cooling is "...the ratio of the rate of net heat removal to the rate of total energy input, calculated under designated operating conditions and expressed in consistent units, as determined using the applicable test method in the *Appliance Efficiency Regulations* or Section 112." [*EES*, Section 101]

COP and EER values may be interchanged according to the following conversion:

3413 Btu = 1 kWh

Therefore,

COP = 0.293 x EER

EER = 3.413 x COP

When heat pump equipment is tested for COP and not HSPF, the following conversions may be assumed:

- Through-the-wall heat pump = 6.6 HSPF (no credit for duct efficiency is allowed)
- Central air conditioning heat pumps = (3.2 x COP) - 2.4 = HSPF

See *Heating, Ventilating and Air Conditioning*; *EER, HSPF* and *SEER*.

Coefficient of Performance, Heating (COP)

The coefficient of performance for heating is "...the ratio of the rate of net heat output to the rate of total energy input, calculated under designated operating conditions and expressed in consistent units, as determined using the applicable test method in the Appliance Efficiency Regulations or Section 112." [*EES,* Section 101]

Air cooled central air conditioning heat pumps manufactured on or after January 1, 1992 have the following minimum COP requirements in heating mode:

Appliance	*COP*
Central Air Cooled Air Conditioning Heat Pumps over or equal to 65,000 Btuh and less than 135,000 Btuh capacity:	
High Temp. Rating (47°F Dry Bulb/ 43°F Wet Bulb)	3.0
Low Temp. Rating (17°F DB/15°F WB)	2.0

See *Heating, Ventilating and Air Conditioning*; *EER* and *SEER*.

Crawl Space

A crawl space is “a space immediately under the first floor of a building adjacent to grade." [*EES*, Section 101]

The thermal characteristics of a crawl space (or any similar vented unheated space below a raised floor) tend to reduce heat loss and heat gain into the building compared with an open, unprotected space below the floor. Compliance credit for the crawl space is assumed to be equivalent to an additional R-6 insulation value (see *Insulation*, *R-Value,* Figures G-4 and G-8). R-6 insulation is *not*

modeled when a raised floor is over an open area or over a garage.

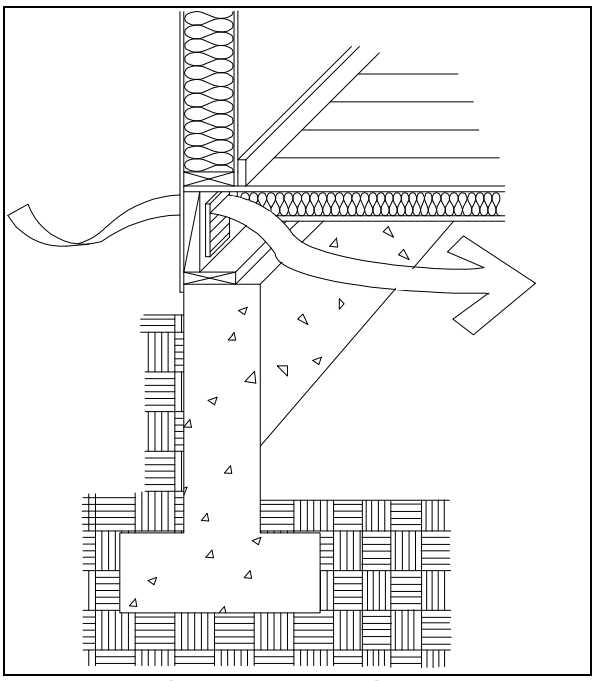


Figure G-4: Crawl Space

An exceptional method for analyzing the energy impact of buildings with raised floors that use foundation wall insulation and automatic crawl space vent dampers has been approved by the Energy Commission and is described under *Controlled Ventilation Crawl Space* in this *Glossary* and Chapter 7, Part 7.7.

Custom Energy Budget

See *Energy Budget*.

Decorative Gas Appliance

A decorative gas appliance is a *"*gas appliance that is designed or installed for visual effect only, cannot burn solid wood, and simulates a fire in a fireplace." [*EES*, Section 101]

A decorative gas appliance installed in a new residential building or addition cannot contain a continuously burning pilot light, and cannot use indoor air for cooling a firebox jacket if the indoor air is vented to the outside of the building. [*EES*, Section 101, 151(e)]

N.B.: Appliances that use indoor air for combustion cannot be used where compliance credit is taken for reduced building infiltration.

Degree Day, Heating

A heating degree day is "a unit, based upon temperature difference and time, used in estimating fuel consumption and specifying nominal annual heating load of a building. For any one day, when the mean temperature is less than 65°F, there exist as many degree days as there are Fahrenheit degrees difference in temperature between the mean temperature for the day and 65°F." [*EES*, Section 101]

Design Conditions

"Design conditions are the parameters and conditions used to determine the performance requirements of space conditioning systems. Design conditions for determining design heating and cooling loads are specified . . . in Section 150(h) for low-rise residential buildings." [*EES*, Section 101]

See also Chapter 2, Part 2.3.

Design Heat Gain

The design heat gain is "...the total calculated heat gain through the building envelope under design conditions." [*EES*, Section 101]

See also Chapter 2, Part 2.3.

Design Heat Loss

The design heat loss is "...the total calculated heat loss through the building envelope under design conditions." [*EES*, Section 101]

See also Chapter 2, Part 2.3.

Directly Conditioned Space

"Directly conditioned space is an enclosed space that is provided with wood heating, is provided with mechanical heating that has a capacity exceeding 10 Btu/(hr×ft²), or . . . mechanical cooling that has a capacity exceeding 5 Btu/(hr×ft²), unless the space conditioning system is designed and thermostatically controlled to maintain a process environment temperature less than 55°F or to maintain a process environment temperature greater than 90°F for the whole space that the system serves, or unless the space conditioning system is designed and controlled to be incapable of operating at temperatures above 55°F or incapable of operating at temperatures below 90°F at design conditions." [*EES*, Section 101]

Dominant Occupancy

In mixed occupancy buildings, the dominant occupancy is the occupancy type with the greatest percentage of total conditioned floor area (see Chapter 7, Part 7.2).

Door

See *Exterior Door*.

Dual-Glazed Greenhouse Windows

“Dual-Glazed Greenhouse Windows are a type of dual-glazed fenestration product which adds conditioned volume but no conditioned floor area to a building.” [*EES*, Section 101]

East-Facing

"East-facing is oriented to within 45 degrees of true east, including 45°0'0" south of east (SE), but excluding 45°0'0" north of east (NE)." [EES, Section 101]

This definition applies only to the the prescriptive packages and master plans analyzed according to the multiple orientation alternative as explained in Chapter 8, Part 8.4. In the computer methods the actual building orientation must be used, except in the case of master plans as stated above.

The designation “East-Facing” is also used in production buildings using orientation restrictions (e.g., Shaded Areas: East-Facing). See Chapter 8, Part 8.4.

EER (Energy Efficiency Ratio)

The energy efficiency ratio (EER) is “the ratio of net cooling capacity (in Btu/hr) to total rate of electrical energy (in watts), of a cooling system under designated operating conditions, as determined using the applicable test method in the Appliance Efficiency Regulation or Section 112." [*EES*, Section 101]

NOTE:

Since few residential buildings use air conditioners or heat pumps with an output capacity greater than 65,000 Btuh, the Low-Rise Residential Standards are expressed in terms of SEER and HSPF ratings, not EER or COP.

The EER of all central air conditioners and central heat pumps with output of 65,000 Btuh and over, manufactured on or after January 1, 1992, and all room air conditioners and room air conditioner heat pumps of 200 volts or more, manufactured on or after January 1, 1990, shall be certified not to be less than the following listed values:

Appliance	*Capacity*	*EER*
Central Air Conditioners		
	65,000 Btuh and over (up to 135,000 Btuh)	8.9
Central Air Source Heat Pumps		
	65,000 Btuh and over (up to 135,000 Btuh)	8.9
Central Water Source Heat Pumps		
	Up to 65,000 Btuh	9.3
	65,000 Btuh and over (up to 135,000 Btuh)	10.5

or the values listed in Table G-3 on the next page.

Table G-3 - Non-Central Space Cooling Equipment

Including Package Terminal Air Conditioners (PTAC); Package Terminal Heat Pumps (PTHP); Room Air Conditioners; and Room Air Conditioner Heat Pumps.

Equipment Type	Size Category (Input)	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure
PTAC (Cooling Mode)	All Capacities	95°F db Outdoor Air	10.0 - (0.16 x Cap/1000)[b] EER	ARI 310/380
		82°F db Outdoor Air	12.2 - (0.20 x Cap/1000)[b] EER	
PTHP (Cooling Mode)	All Capacities	95°F db Outdoor Air	10.0 - (0.16 x Cap/1000)[b] EER	
		82°F db Outdoor Air	12.2 - (0.20 x Cap/1000)[b] EER	
PTHP (Heating Mode)	All Capacities		2.9 - (0.026 x Cap/1000)[b] COP	
Room Air Conditioners, with Louvered Sides	< 6,000 Btu/h		8.0 EER	ANSI/AHAM RAC-1
	≥6,000 Btu/h and < 8,000 Btu/h		8.5 EER	
	≥ 8,000 Btu/h and < 14,000 Btu/h		9.0 EER	
	≥14,000 Btu/h and < 20,000 Btu/h		8.8 EER	
	≥20,000 Btu/h		8.2 EER	
Room Air Conditioners, without Louvered Sides	< 6,000 Btu/h		8.0 EER	
	≥6,000 Btu/h and < 20,000 Btu/h		8.5 EER	
	≥20,000 Btu/h		8.2 EER	
Room Air Conditioner Heat Pumps with Louvered Sides	All Capacities		8.5 EER	
Room Air Conditioner Heat Pumps without Louvered Sides	All Capacities		8.0 EER	
Room Air conditioners & Room Heat Pumps Not Covered by Federal Regulations				
Room Air Conditioners & Heat Pumps	200 volts or more		8.2 EER	10 Code of Federal Regs. Section 430.22(f)
Room Air Conditioners	Less than 200 volts		8.7 EER	
Room Heat Pumps			8.3 EER	

[b] Cap means the rated cooling capacity of the product in Btu/h. If the unit's capacity is less than 7000 Btu/h, use 7000 Btu/h in the calculation. If the unit's capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculation.

[c] Replacement units must be factory labeled as follows: "MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS." Replacement efficiencies apply only to units with existing sleeves less than 16-in. high and less than 42-in. wide.

COP and EER values may be interchanged according to the following conversion:

3413 Btu = 1 kWh

Therefore,

COP = 0.293 x EER

EER = 3.413 x COP

For equipment that is not tested for SEER the EER may be used as the SEER.

See *Heating, Ventilating and Air Conditioning*; *COP* and *SEER*.

Efficacy

"Efficacy is the ratio of light from a lamp to the electrical power consumed (including ballast losses), expressed in lumens per watt." [*EES*, Section 101]

See also *Lumens/Watt*.

Electric Resistance Heating

As mentioned in the explanation of *Energy Budget* in this *Glossary*, electricity is inherently less efficient than gas as a heating energy source because it must account for losses associated with generation from depletable fossil fuels and transmission to the building site. A source energy multiplier of 3.0 (representing a net efficiency of 33 percent) is assigned to electricity by the standards. Table G-11 lists the number of Btu of source energy per kilowatt-hour of electricity.

Electric resistance baseboard heaters are assumed to have a property line efficiency of 1.00 and an equivalent HSPF of 3.413.

Electric radiant heating panels may be assigned a slightly higher efficiency of 1.04 (equivalent HSPF of 3.550) owing to their mode of delivering sensible heat if the following criteria are met:

1. The radiant heating is installed on the interior surface of the building envelope.
2. The radiant surface is not likely to be behind furnishings (i.e. it is installed high on a wall or on a ceiling).
3. The radiant surface is not designed with fins or covers.
4. The radiant surface does not use a fan to deliver its heat.

Enclosed Space

"Enclosed space is space that is substantially surrounded by solid surfaces." [*EES*, Section 101]

Energy Budget

“Energy budget is the maximum amount of source energy that a proposed building, or portion of a building, can be designed to consume, calculated with the approved procedures specified in Title 24, Part 6.” [*EES*, Section 101]

The low-rise residential standards are based upon the concept of an annual energy budget. This is the measure of source energy used per year in a building. The energy budget for low-rise residential buildings includes space heating, space cooling and domestic water heating. To comply with the standards, the energy use of the proposed building design must be less than the annual energy budget.

The standard design is made up of features required in prescriptive package D and are used to determine the annual energy budget. Each approved computer method automatically generates a custom energy budget by calculating the annual energy use of the standard design.

The energy budget allows a "trade-off" of part of the space conditioning budget for part of the water heating budget, or vice versa. This is explained further in Chapter 5, Part 5.2.

The space conditioning component of the energy budget is measured in thousands of British thermal units (kBtu) consumed per square foot of conditioned floor area per year. Water heating is calculated in kBtu per dwelling unit per year and then divided by the building floor area to convert to kBtu per square foot per year.

Source energy accounts for all of the energy used in delivering energy to the building site including power generation, transmission and distribution. See *Source Energy* for conversion rates. See *Glossary* Table G-11 for source energy conversion rates for electricity, natural gas, fuel oil and propane.

See also *Proposed Design, Standard Design*, and *Source Energy*.

Energy Efficiency Standards

The California state energy standards as set forth in the California Code of Regulations, Title 24, Part 6 (see Chapter 1, Part 1.1).

Energy Factor (EF)

Used to measure the efficiency of water heaters, the Energy Factor (EF) is "the ratio of energy output to energy consumption of a water heater, expressed in equivalent units, under designated operating conditions over a 24-hour use cycle, as determined using the applicable test method in the Appliance Efficiency Regulations." [*EES*, Section 101]

The Energy Factor of all new small water heaters manufactured on or after April 15, 1991 shall be certified to be not less than the following:

Water Heater Type	*Energy Factor*
Gas	0.62 - (.0019 x V)
Electric (including Heat Pump)	0.93 + (.00132 x V)
Oil	0.59 - (.0019 x V)

"V" equals rated volume in gallons.

Energy Obtained From Depletable Sources

"Energy obtained from depletable sources is electricity purchased from a public utility, or energy obtained from burning coal, oil, natural gas, or liquefied petroleum gases." [*EES*, Section 101]

Energy Obtained From Nondepletable Sources

Also referred to as renewable energy, including solar and wind power, energy from non-depletable sources is defined as energy that is not obtained from depletable sources. [*EES*, Section 101]

Enforcing Agency

The enforcing agency is "the city, county, or state agency responsible for issuing a building permit." [*EES*, Section 101]

Evaporative Cooler

Evaporative coolers may be installed as an alternative to air conditioning, particularly in climate zones with dry air. These systems use water evaporation and air circulation to provide cooling. Evaporative coolers use less energy for cooling than minimum efficiency air conditioners, so the Energy Commission has established higher SEERs to use when modeling them for compliance. See Chapter 8, Part 8.10 for details on this credit, including eligibility and installation criteria.

Evaporative coolers provide cooling to a building by either direct contact with water (direct evaporative cooler), or a combination of a first stage heat exchanger to pre-cool building air temperature and a second stage with direct contact with water (indirect/direct evaporative cooler).

Credit for evaporative coolers is allowed in either single-family detached or single-family attached residences. *No credit is allowed for evaporative coolers in multi-family buildings*. See Chapter 8, Part 8.10 for the credit and installation criteria.

NOTE:

In hot and humid climates, the following characteristics of evaporative cooling should be considered:

- Direct evaporative coolers in climates that are both hot and humid may result in uncomfortable indoor humidity levels.
- Indirect/direct evaporative coolers do not increase indoor humidity as much as direct systems, and would be unlikely to produce uncomfortable indoor humidity levels, even in hot, humid areas.
- Evaporative coolers may not reduce indoor temperatures to the same degree as air conditioning.

See Chapter 8, Part 8.10.

Exceptional Method

If an "alternative calculation method [ACM] analyzes designs, materials, or devices that cannot be adequately modeled using the public domain computer programs, the method may be approved [by the Commission] as an exceptional method. Applications for approval of exceptional methods shall include theoretical and empirical information that verify the method's accuracy, and shall also include the other documentation and fees required by subsection 10-109(b)." [*EES*, Section 109(b)4]

Two examples of exceptional methods are the controlled ventilation crawl space (CVC) credit (see *Glossary* entry and Chapter 8, Part 8.7) and the combined hydronic space and water heating method (see Chapter 5, Part 5.4P and Chapter 8, Part 8.9). Other exceptional methods are also

included in Chapter 8. Exceptional methods can be approved at any time. The Energy Commission distsributes a public notice whenever such methods are approved with instructions for achieving the alloted credit.

Exfiltration

Exfiltration is unwanted conditioned air leakage from a building. This term is usually mentioned in conjunction with infiltration. All compliance approaches require some type of infiltration/ exfiltration controls as described later in this Glossary and in Chapter 2, Part 2.2.

Exterior Door

An exterior door is any openable opaque surface that separates conditioned and unconditioned space. A door with one half or less of the surface area as glazing is an exterior door. A door with more than 50 percent of its surface area made up of glazing is a fenestration product. [*EES*, Section 101] This distinction affects labeling and certification requirements for the product.

Glass in doors must be counted as part of the total fenestration area. The area to be included must be either the entire door area or the actual area of the glazing plus a two inch frame extension on all sides.

Any door that receives an NFRC rating should be modeled as an entire fenestration unit with the rated U-value and solar heat gain coefficient (these values are based on the entire product, including the framing).

Solid (opaque) door area is ignored in the prescriptive packages but must be included in the computer performance approach (see Chapter 5, Part 5.4B).

Exterior Floor/Soffit

An exterior floor or soffit is "a horizontal exterior partition, or a horizontal demising partition, under conditioned space. For low-rise residential occupancies, exterior floors also include those on grade." [*EES*, Section 101]

Exterior Partition

An exterior partition is “an opaque, translucent, or transparent solid barrier that separates conditioned space from ambient air [outdoors] or space that is not enclosed. For low-rise residential occupancies, exterior partitions also include barriers that separate conditioned space from unconditioned space, or the ground." [*EES*, Section 101]

Exterior Roof/Ceiling

An exterior roof or ceiling is "...an exterior partition, or a demising partition, that has a slope less than 60 degrees from horizontal, that has conditioned space below, and that is not an exterior skylight." [*EES*, Section 101]

Exterior Wall

An exterior wall "is any wall or element of a wall, or any member or group of members, which defines the exterior boundaries or courts of a building and which has a slope of 60 degrees or greater with the horizontal plane. An exterior wall or partition is not an exterior floor/soffit, exterior door, exterior roof/ceiling, window, skylight, or demising wall. [*EES*, Section 101]

Exterior Wall Area

"Exterior wall area is the area of the opaque exterior surface of exterior walls." [*EES*, Section 101]

An exterior wall is distinguished from an exterior roof/ceiling by its angle of tilt. A wall is a surface with a tilt of greater than or equal to 60 degrees measured from the horizontal.

The area of bermed (underground) walls between conditioned space and below grade is treated differently depending on the compliance approach. See Chapter 3 (prescriptive) or Chapter 5 (computer) for the correct procedures for below grade walls in a conditioned space.

Fenestration Area (Glazing Area)

Fenestration area is defined as the area of all fenestration products (i.e., windows, skylights and glass doors) in exterior openings, including the sash or frame area. The nominal area (from nominal dimensions such as $4^{o}4^{o}$) or rough opening is also acceptable.

For details on calculating fenestration area for glass doors, see *Exterior Door*.

Where the term "glazing area" is used in the standards it means the entire fenestration area, not just the area of glazing, unless stated otherwise (see Figure G-5).

See *Fenestration Product*, *Glazing* and *Shading*.

Fenestration Product

A fenestration product is: “any transparent or translucent material plus any sash, frame, mullions, and dividers, in the envelope of a building, including, but not limited to: windows, sliding glass doors, french doors, skylights, curtain walls, garden windows, and other doors with a glazed area of more than one-half of the door area.” [*EES*, Section 101]

Table G-4 contains default values for fenestration product U-value from Section 116 of the standards. Default values for Solar Heat Gain Coefficient are found under the heading *Shading* in this Glossary. Additional information contained in this manual is:

- An explanation of glazing terminology and thermal performance rating system for all fenestration products in Chapter 8, Part 8.5.
- Certification, labeling and mandatory requirements for fenestration products are included in Chapter 2.
- Additions and alterations compliance issues related to fenestration are discussed in Chapter 7.
- Fenestration topics related to prescriptive and computer compliance are found in chapters 3 and 5.

Fireplace

A fireplace is a “hearth and fire chamber or similar prepared place in which a solid fuel fire may be burned, as defined in UBC Section 3102 ; these include but are not limited to factory-built fireplaces, masonry fireplaces, and masonry heaters." [*EES*, Section 101]

See Chapter 2, Part 2.2 and Figure 2-6 for mandatory requirements regarding fireplace installation.

Floor Area

See *Conditioned Floor Area*.

Footprint Area

See *Conditioned Footprint Area*.

Fossil Fuels

Fossil fuels are fuels which are derived from natural gas, coal, oil and liquefied petroleum products. These are generally nonrenewable resources, although natural gas may also be produced by other means, such as biomass conversion.

Framing Effects

The type and amount of framing in walls, roofs/ceilings and floors affects the overall U-value of the surface. For compliance, fixed values for wood framing percentages must be used when a parallel path U-value is calculated. Alternatively, precalculated U-values that include frame effects may be used for both wood and metal frame assemblies. Refer to Tables G-12 through G-16 and the *R-Value* discussion of this *Glossary*.

Front

The primary entry side of the building (front facade) used as a reference in defining the orientation of the building or unit plan (see Chapter 5, Part 5.4A and Figure 5-2). The orientation of the front facade may not always be the same as that for the front door itself.

This designation is used on the Certificate of Compliance (CF-1R form) to indicate the orientation of a custom building (e.g., Front Entry Orientation: North). See also *North-Facing*, *East-Facing*, etc.

Gas Heating System

See *Heating*, *Ventilation* and *Air Conditioning*.

Gas Log

A gas log is "a self-contained, free-standing, open-flame, gas-burning appliance consisting of a metal frame or base supporting simulated logs and designed for installation only in a vented fireplace." [*EES*, Section 101]

Table G-4: DEFAULT FENESTRATION PRODUCT U-VALUES

Frame Type[1]	Product Type	Single Pane U-value	Double Pane U-value[2]
Metal	Operable	1.28	0.87
Metal	Fixed	1.19	0.72
Metal	Greenhouse/Garden window	2.26	1.40
Metal	Doors	1.25	0.85
Metal	Skylight	1.72	0.94
Metal, Thermal Break	Operable		0.71
Metal, Thermal Break	Fixed		0.60
Metal, Thermal Break	Greenhouse/Garden window		1.12
Metal, Thermal Break	Doors		0.64
Metal, Thermal Break	Skylight		0.80
Non-Metal	Operable	0.99	0.60
Non-Metal	Fixed	1.04	0.57
Non-Metal	Doors	0.99	0.55
Non-Metal	Greenhouse/Garden windows	1.94	1.06
Non-Metal	Skylight	1.47	0.68

[1] Metal includes any field-fabricated product with metal cladding. Non-metal framed manufactured fenestration products with metal cladding must add 0.04 to the listed U-value. Non-Metal frame types can include metal fasteners, hardware, and door thresholds. Thermal break product design characteristics are:

a. The material used as the thermal break must have a thermal conductivity of not more than 3.6 Btu-inch/hr/ft^2/°F,
b. The thermal break must produce a gap of not less than 0.210", and
c. All metal members of the fenestration product exposed to interior and exterior air must incorporate a thermal break meeting the criteria in (a) and (b) above.

In addition, the fenestration product must be clearly labeled by the manufacturer that it qualifies as a thermally broken product in accordance with this standard.

[2]For all dual glazed fenestration products, adjust the listed U-values as follows:

a. Subtract 0.05 for spacers of 7/16" or wider.
b. Subtract 0.05 for products certified by the manufacturer as low-E glazing.
c. Add 0.05 for products with dividers between panes if spacer is less than 7/16" wide.
d. Add 0.05 to any product with true divided lite (dividers through the panes).

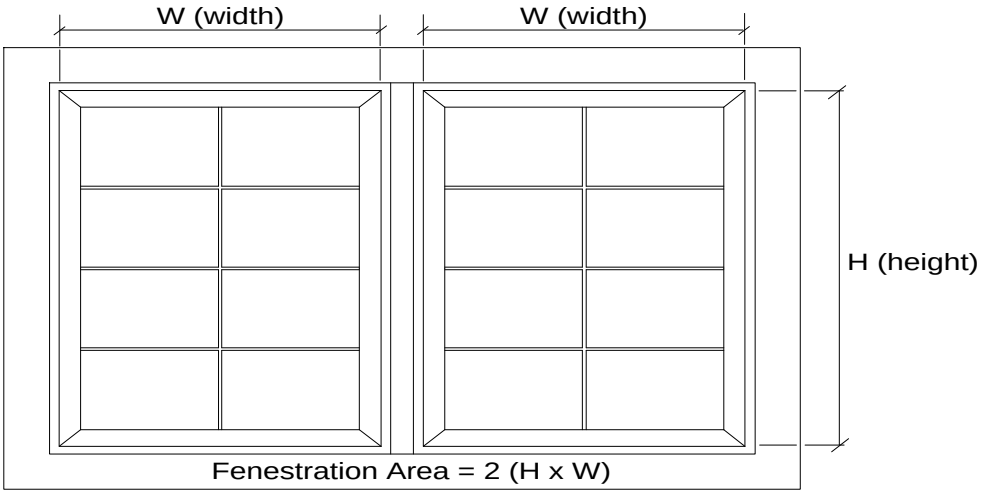


Figure G-5: Fenestration Area

General Lighting

"General lighting is lighting designed to provide a substantially uniform level of illumination throughout an area, exclusive of any provision for special visual tasks or decorative effect. When designed for lower-than-task illuminance used in conjunction with other specific task lighting systems, it is also called "ambient" lighting." [*EES*, Section 101]

As used for kitchen lighting, general lighting must provide a sufficient light level for basic kitchen tasks and provide a uniform pattern of illumination. [*EES*, Section 150(k)1]

See also *Lighting*, *Task Lighting* and Chapter 2, Part 2.5.

Geothermal Heat Pump

A heat pump that uses the earth as a source of energy for heating and a sink for energy when cooling. Some systems pump water from an acquifer in the ground and return the water to the ground after transferring heat from or to the water. A few systems use refrigerant directly in a loop of piping buried in the ground. Those heat pumps that use either a water loop or pump water from an acquifer have efficiency test methods that are accepted by the Energy Commission. These efficiency values are certified to the Energy Commission by the manufacturer and are expressed in terms of heating Coefficient of Performance (COP) and cooling Energy Efficiency Ratio (EER).

See part 8.11.

Glazing

Glazing is defined as the translucent portion of any fenestration product, typically glass.

See *Fenestration Product* and *Shading*, and Chapter 8, Part 8.5.

Ground Floor Area

For compliance, the ground floor area is defined as the slab-on-grade area of a slab-on-grade building and the conditioned footprint area of a raised floor building.

Ground Source Heat Pump

See *Geothermal Heat Pump*.

Habitable Story

A habitable story in a building is a story that "contains space in which people may work or live in reasonable comfort. A habitable story is defined as having at least 50 percent of its volume above grade." [*EES*, Section 101] The standards use this definition to determine whether a building is high-rise or low-rise.

See also *Conditioned Floor Area*, *High-Rise Residential* and *Low-Rise Residential*.

Heat Capacity (HC)

The heat capacity of an assembly is “the amount of heat necessary to raise the temperature of all the components of a unit area in the assembly one degree F. It is calculated as the sum of the average thickness times the density times the specific heat for each component, and is expressed in Btu per square foot per degree F." [*EES*, Section 101]

See *Areal Heat Capacity*.

Heat Pump

A heat pump is an air conditioner capable of heating by refrigeration. It may or may not include a capability for cooling. Outside air or water is used as a heat source or heat sink, depending upon whether the system is heating or cooling.

Heat pump efficiency is measured according to the HSPF rating (see HSPF) which is a function of both the condensing unit (compressor) and the type of coil selected to be used with it. Equipment manufacturers typically list efficiencies only of certain compressor-coil combinations.

Heat pumps may be either split system or single packaged units as defined above under Air Conditioner.

See also *HSPF (Heating Seasonal Performance Factor)*.

Heating, Ventilating and Air Conditioning (HVAC)

The mechanical heating, ventilating and air conditioning system of the building is also known as the HVAC system. The standards use various measures of equipment efficiency defined according to the type of equipment installed.

Gas (fossil fuel) heating equipment is rated according to its Annual Fuel Utilization Efficiency (AFUE). The heating efficiency of electric heat pumps with less than 65,000 Btuh cooling capacity is rated according to Heating Seasonal Performance Factor (HSPF). The heating efficiency of heat pumps with cooling capacity of 65,000 Btuh or more is rated according to Coefficient of Performance (COP). Electric resistance heating is rated according to its HSPF.

All electric cooling with less than 65,000 Btuh output capacity is rated according to the Seasonal Energy Efficiency Ratio (SEER). Electric cooling with an output capacity of 65,000 Btuh or more is rated according to its Energy Efficiency Ratio (EER). (Heat pump cooling is rated according to its SEER or EER, and heat pump heating by the HSPF or COP).

Since few residential buildings use air conditioners or heat pumps with an output capacity greater than 65,000 Btuh, the Low-Rise Residential Standards only use SEER and HSPF ratings, not EER or COP.

Air Conditioners

See *Air Conditioner* in this Glossary.

Certification

Commission regulations specify that:

"Any appliance for which there is a California standard established in the Appliance Efficiency Regulations may be installed only if the manufacturer has certified to the Commission, as specified in those regulations, that the appliance complies with the applicable standard for that appliance." [*EES*, Section 111]

HVAC equipment subject to certification includes:

- Room air conditioners
- Central air conditioners with a cooling capacity less than 135,000 Btu/hr
- Central air conditioning heat pumps
- Fan type central furnaces with input rate less than 400,000 Btu per hour
- Boilers
- Wall furnaces
- Floor furnaces
- Room heaters
- Unit heaters
- Duct furnaces

The following types of gas space heaters do not need to be certified:

- Gravity type central furnaces
- Heaters installed in mobile homes at the time of construction

- Heaters designed expressly for use in recreational vehicles and other mobile equipment
- Fan type central furnaces with input rates of at least 400,000 Btu per hour
- Infrared heaters

See *EES*, Secion 110, Chapter 2, Part 2.4, and the *Appliance Efficiency Regulations* for further information concerning certification and efficiency requirements for appliances, including refrigerators, water heaters, plumbing fittings and fluorescent lamp ballasts.

Directories of certified heating and cooling systems can be accessed or obtained according to information provided in Appendix E.

Equipment efficiencies and other specifications listed in the directories can also be obtained by contacting the Commission Energy Hotline (see Chapter 1, Part 1.6) or from the Commission's website at www.energy.ca.gov/efficiency/-appliances/.

Combined Hydronic Space and Water Heating

For a discussion of combined hydronic space and water heating, see Chapter 5, Part 5.4P and Chapter 8, Part 8.9.

Duct Losses

The mandatory minimum insulation R-value for ducts that carry conditioned air (heated or cooled) through conditioned space is R-4.2, unless the *Uniform Mechanical Code* requires a higher insulation level. (See Chapter 2, Part 2.4 for complete information on duct construction and mandatory duct requirements). For space conditioning systems without ducts, or where ducts are located wholly within conditioned space, or where duct insulation exceeds R-4.2, credit for reduced duct heat losses and gains is accounted for in the computer compliance approach (see Chapter 5). See Chapter 4 for diagnostic testing and verification of duct performance.

Efficiency Conversions

When equipment is not tested for SEER, the EER may be used as the SEER. When heat pump equipment is not tested for HSPF, the following conversions may be assumed:

Through-the-wall heat pump = 6.6 HSPF (no credit for duct efficiency is allowed)

Central air conditioning heat pumps, HSPF = (3.2 x COP) - 2.4

Electric Resistance Heating

See *Electric Resistance Heating* in this Glossary.

Gas Furnaces, *Room Heaters* and *Boilers*

Heating systems that utilize natural gas, liquefied petroleum gas or oil are rated by the Energy Commission according to their Annual Fuel Utilization Efficiency (AFUE).

For gas fan type central furnaces manufactured on or after January 1, 1992 the minimum allowed AFUE is 78 percent. See *AFUE* for other types of equipment.

The following gas space heaters are exempt from this requirement:

- Gravity type central furnaces
- Fan type central furnaces with input rates at least 400,000 Btu per hour
- Infrared heaters

Table 1-C of the standards states that gas-fired warm air furnaces greater than or equal to 225,000 Btuh must have 80 percent thermal efficiency at maximum rated capacity.

Heat Pump

See *Heat Pump* in this Glossary.

Packaged Air Conditioner

A packaged air conditioner combines both condenser and air handling capabilities in a single packaged unit.

Split System Air Conditioner

A split system air conditioner has physically separate condenser and air handling units that work together as a single cooling system.

Wood Heater

Wood heaters and the compliance guidelines and installation criteria are in Chapter 8, Part 8.6.

Zonal Control

See *Zonal Control* in this Glossary, and criteria for obtaining credit for such systems is explained in Chapter 8, Part 8.8.

High-Rise Residential

A high-rise residential building is “a building, other than a hotel/motel, of occupancy group R-1 with four or more habitable stories." [*EES*, Section 101]

All hotels and motels, regardless of the number of stories, and multi-family residential buildings with four or more habitable stories must comply with Sections 120 through 149 of the standards (Nonresidential and High-Rise Residential Standards), rather than Sections 150 through 152 (Low-Rise Residential Standards).

See Chapter 1, Part 11.2.

HSPF (Heating Seasonal Performance Factor)

The Heating Seasonal Performance Factor (HSPF) is “the total heating output of a heat pump (in British thermal units) during its normal usage period for heating divided by the total electrical energy input (in watt-hours) during the same period, as determined using the applicable test method in the Appliance Efficiency Regulations." [*EES*, Section 101]

HSPF is the heating efficiency measure used for heat pumps and electric furnaces under the current standards. Derived from laboratory tests mandated by the U.S. Department of Energy, the HSPF predicts the Btu of heat output for each watt-hour of input electricity for an average U.S. climate.

HSPF is a rating designed to allow the consumer to easily compare one heat pump with another on the basis of nominal efficiency and, as such, is a reasonable predictor of relative performance.

All air-cooled central air conditioning heat pumps manufactured on or after January 1, 1992 must have the HSPF values listed below:

Appliance	HSPF
Central Air Source Heat Pumps up to 65,000 Btuh:	
Split System	6.8
Single Package	6.6

For equipment that is not tested for HSPF, the following conversions may be assumed:

- Through-the-wall heat pump = 6.6 HSPF (no credit for duct efficiency is allowed)
- Central air conditioning heat pumps that do not have an HSPF rating for heating but have a COP rating, HSPF = (3.2 x COP) - 2.4

See *Heating*, *Ventilating* and *Air Conditioning* and *Coefficient of Performance (COP)*.

HVAC

See *Heating*, *Ventilating* and *Air Conditioning.*

Hydronic Space Heating

A hydronic space heating system is one using water heating equipment, such as a storage tank water heater or a boiler, to provide space heating. Hydronic space heating includes both radiant floor systems and convective or fan coil systems. The method for analyzing hydronic space heating systems is explained in Chapter 5, Part 5.4P and Chapter 8, Part 8.9.

See also *Combined Hydronic Space/Water Heating*.

Indirectly Conditioned Space

“Indirectly conditioned space is enclosed space including, but not limited to, unconditioned volume in atria, that (1) is not directly conditioned space; and (2) either (a) has an area-weighted heat transfer coefficient to directly conditioned space exceeding that to the outdoors or to unconditioned space, or (b) is a space through which air from directly conditioned spaces is transferred at a rate exceeding 3 air changes per hour.” [*EES*, Section 101]

Indirectly conditioned space must be included when calculating total conditioned floor area. Examples of areas that *may* be indirectly conditioned space include enclosed porches, enclosed sunrooms, laundry rooms and furnace closets. See Figure G-6 for an example.

Infiltration

“Infiltration is uncontrolled inward air leakage from outside a building, or unconditioned space, including leakage through cracks and interstices, around windows and doors, and through any other exterior or demising partition or pipe or duct penetration.” [*EES*, Section 101]

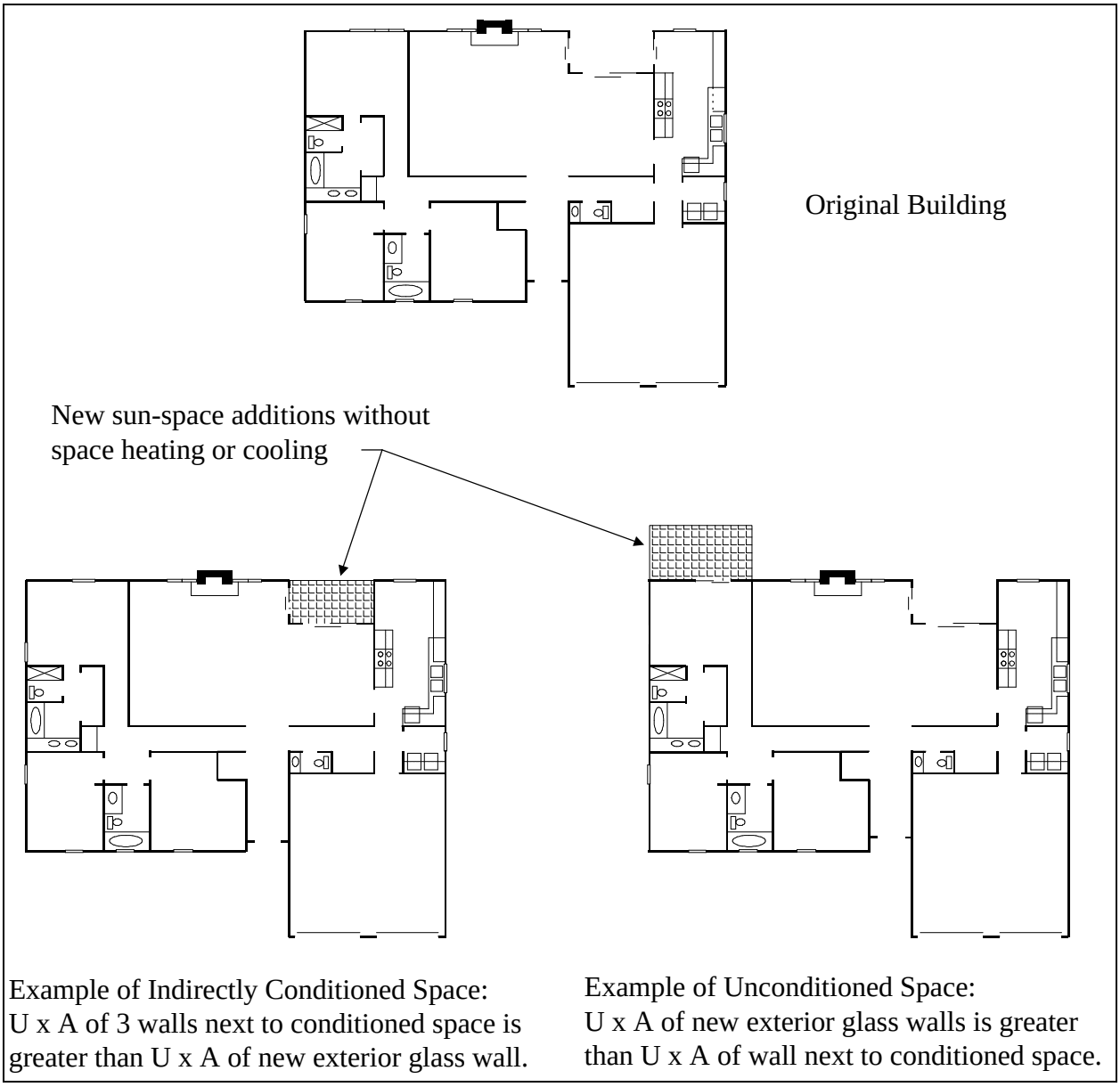


Figure G-6: Unconditioned vs. Indirectly Conditioned

Infiltration Controls

Infiltration of air can be controlled in various ways, many of which are mandatory measures and therefore considered "standard" in new residential construction. Mandatory Infiltration control measures include weatherstripping, caulking and sealing in and around all exterior joints and openings as explained in Chapter 2.

See Chapter 4 for diagnostically measured infiltration reduction in the performance approach. For the prescriptive approach, "tight" infiltration controls are only required for compliance with Alternative Component Package B in Climate Zones 1, 14, 15, and 16. Tight controls include all the standard requirements, plus a continuous infiltration barrier that meets Energy Commission quality standards and a mechanical ventilation system with an air-to-air heat exchanger that can ventilate at 0.7 air changes per hour or higher. See Special Infiltration Barrier and Vapor Barrier in Chapter 2, Part 2.3,. and Continuous Infiltration Barrier and air-to-air heat exchanger in Chapter 3, Part 3.2 for additional information including installation requirements.

Insulation

Insulating material of the types and forms listed in 118(a) of the standards (Chapter 2, Part 2.3) “may be installed only if the manufacturer has certified that the insulation complies with the California Quality Standards for Insulating Material, Title 20, Chapter 4, Article 3.” [*EES*, Section 118(a)]

Insulation must be placed within or contiguous with a wall, ceiling or floor, or over the surface of any appliance or its intake or outtake mechanism for the purpose of reducing heat transfer or reducing adverse temperature fluctuations of the building, room or appliance.

Insulation may be installed in wall, ceiling/roof and raised floor assemblies and at the edge of a slab-on-grade. Movable insulation is designed to cover windows and other glazed openings part of the time to reduce heat loss and heat gain.

Insulation R-Value

The R-value of insulation or any material or building component is the measure of its thermal resistance expressed in ft2-hr-°F/Btu (see R-Value). This value may be obtained from Appendix B or from manufacturer's literature.

The rated R-value of mineral fiber (batt) insulation is based upon its fully expanded thickness. When the insulation is compressed, the R-value is reduced. For example, an R-19 batt of insulation expands to a thickness of 6 inches. If it is compressed into 2x6 framing with an actual depth of 5.5 inches, the insulation R-Value is lowered to R-17.8. See Table G-5 for some common compressed insulation values.

Table G-5: R-Values for Compressed Mineral Fiber Batt Insulation[1]

Standard Compressed R-Value	Nominal Lumber Size	Actual Cavity Depth	R-Value
13 (3.625")	2x4	3.5"	13
19 (6.25")	2x6	5.5"	17.8
22 (6.75")	2x6	5.5"	20
30 (9.5")[2]	2x10	9.25"	30
38 (12")[2]	2x12	11.25"	37

1. Based on manufacturer's data.
2. Note that batt insulation with these R-values is available in smaller thicknesses. R-30 may be achieved with an 8.25" to 8.5" batt, and R-38 may be achieved with a 10.25" to 10.5" batt. If this thinner insulation is used in the framing sizes listed here, the insulation would retain its full rated R-value because it would not be compressed.

Interior Partition

An interior wall or floor/ceiling that separates one area of conditioned space from another within the building envelope.

Left

"Left" indicates the left side of the building as one faces the front facade from the outside (see Front).

This designation is used on the Certificate of Compliance (CF-1R form) to indicate the orientation of fenestration (e.g., Left-East). See also *West-Facing*, etc.

Lighting

The lighting requirements in the low-rise Residential Standards are the mandatory measures for kitchen and bathroom lighting, and for incandescent lighting fixtures recessed into insulated ceilings (*EES*, 150(k)).

Both kitchens and rooms containing a bathtub or shower are required to have at least one luminaire with lamps that have an efficacy of at least 40 lumens per watt. For kitchens, this luminaire must be used for general lighting (see *General Lighting*). For bathrooms, the standards allow an alternative to the requirement by (1) installing the 40 lumens per watt fixture in a utility room, laundry room, or garage, and (2) installing 40 lumens per watt fixtures in all permanently mounted outside fixtures or equipping the fixtured with a motion sensor. There are additional mandatory requirements and installation criteria contained in Chapter 2, Part 2.5.

Table 2-6 lists typical lamp and lamp/ballast efficacies. Fluorescent lamps are generally used to meet these requirements. Screw-in compact fluorescents, however, are used with medium base incandescent lamp sockets, so they do not qualify. Hard-wired compact fluorescents where the ballast is part of the luminaire and that have an efficacy of at least 40 lumens per watt do meet these requirements.

See Chapter 2, Part 2.5 for a complete explanation of all the mandatory lighting requirements, including installation criteria.

Low-Rise Residential

Any building of occupancy group R, excluding all hotels, all motels and apartment buildings with four or more habitable stories.

Lumens/Watt

A lumen is a measure of the amount of light available from a given light source. A watt is a measure of the power requirement for that light source. The efficacy of a light source is measured by dividing the lumens by the wattage. The more usable light that a light source provides per watt, the greater its energy efficiency.

Manufactured Device

A manufactured device is “any heating, cooling, ventilation, lighting, water heating, refrigeration, cooking, plumbing fitting, insulation, door, fenestration product, or any other appliance, device, equipment or system subject to Sections 110 through 119 of Title 24 Part 6." [*EES*, Section 101]

Mixed Occupancy

A building designed and constructed for more than one type of occupancy, such as a three story building with ground floor retail and second and third floor residential apartments (see Chapter 8, Part 8.2).

Multi-Family

A dwelling unit of occupancy type R, as defined by the *UBC*, sharing a common wall and/or ceiling/floor with at least one other dwelling unit (see Chapter 8, Part 8.1). See also *Building Type*.

NFRC

The National Fenestration Rating Council. A national organization of manufacturers of fenestration products, glazing and related materials, plus utilities, state energy offices, laboratories, home builders, specifiers (architects) and public interest groups.

This organization is responsible for rating the U-values and solar heat gain coefficient of manufactured fenestration products (i.e., windows, skylights, glazed doors) that must be used in compliance calculations. All manufactured fenestration products must be labeled with NFRC rated values or with the default U-values listed in Table G-4 for compliance with the standards (see also Chapter 2, Part 2.3 and Chapter 8, Part 8.5).

See also *Fenestration Area* and *Fenestration Product*.

North-Facing

"North-facing is oriented to within 45 degrees of true north, including 45°0'0" east of north (NE), but excluding 45°0'0" west of north (NW)." [*EES*, Section 101]

This definition applies only to the prescriptive packages and master plans analyzed according to the multiple orientation alternative as explained in Chapter 8, Part 8.4. In the computer methods the actual building orientation must be used, except in the case of master plans as stated above.

Outside Air

"Outdoor air (Outside air) is air taken from outdoors and not previously circulated in the building." [*EES*, Section 101]

Proposed Design

The proposed building design which must comply with the standards before receiving a building permit. See also *Energy Budget* and *Standard Design*.

Radiant Barriers

The Energy Commission has approved an energy credit for radiant barriers meeting specific eligibility and installation criteria. The radiant barrier energy credit is an adjustment to the ceiling U-value when the ceiling is adjacent to an attic with a radiant barrier. The credit is available only with computer compliance with an energy budget. See Chapter 8, Part 8.13 for details on the required eligibility and installation criteria. See Chapter 5, Part 5.4N for modeling details.

Raised Floor

A "raised floor is a floor (partition) over a crawl space, or an unconditioned space, or ambient air." [*EES*, Section 101]

See Chapters 3 and 5, and the *Glossary* definition of *Conditioned Footprint Area*.

Readily Accessible

“Readily accessible is capable of being reached quickly for operation, repair, or inspection, without requiring climbing or removing obstacles, or resorting to access equipment." [*EES*, Section 101]

Rear

See *Back*.

Recovered Energy

"Recovered energy is energy used in a building that (1) is mechanically recovered from space conditioning, service water heating, lighting or process equipment after the energy has performed its original function; (2) provides space conditioning, service water heating or lighting; and (3) would otherwise be wasted." [*EES*, Section 101]

An air-to-air heat exchanger is an example of a system that recovers energy of this kind.

Recovery Efficiency

Recovery efficiency is one measure of the efficiency of water heaters. It is required for water heating energy calculations for some types of water heaters (see Chapter 6). It is “a measure of the percentage of heat from combustion of gas or oil which is transferred to the water. For non-storage type water heaters, the recovery efficiency is really a thermal efficiency." [*AER*, Section 1602]

Repair

“Repair is the reconstruction or renewal of any part of an existing building for the purpose of its maintenance. Note: Repairs to low-rise residential buildings are not within the scope of these standards.” [EES, Section 101]

Right

"Right" indicates the right side of the building as one faces the front facade from the outside (see *Front*). This designation is used on the Certificate of Compliance (CF-1R form) to indicate the orientation of fenestration (e.g., Right-West). See also *North-Facing*, *East-Facing*, etc.

Roof

See *Exterior Roof/Ceiling*.

R-Value (Thermal Resistance)

The R-value of a material is “the [thermal] resistance of a material or building component to the passage of heat in (hr x ft^2 x ºF)/Btu." [*EES*, Section 101]

The R-value indicates how well a material prevents heat from flowing through it. R-19 insulation, for example, is only half as effective at slowing heat transfer as R-38 insulation.

When more than one material is put in series with another in a construction assembly (such as exterior siding, insulation and interior gypsum board), the thermal resistance of the assembly is equal to the sum of the individual resistances (see Figures G-7 and G-8).

NOTE:

For heat flow through a series of layers adding the U-values of the individual layers of an assembly does not produce the total U-value. Thermal resistances (R-values) must first be added and the total resistance (R_{Total}) divided into 1 to yield the correct U-value.

Correct:

$$U = \frac{1}{R_1 + R_2 + ... + R_n} = \frac{1}{R_{Total}}$$

Incorrect:

$$U = \frac{1}{R_1} + \frac{1}{R_2} + ... + \frac{1}{R_n} = U_1 + U_2 + ... + U_n$$

The inverse of the total R-value is the U-value:

$$U = 1/R_{Total}$$

The U-value is the heat transfer coefficient expressed in Btu/ft^2-hr-^{o}F, the rate at which heat flows through an assembly or material.

The total R-value should be calculated to two decimal places, and the total U-value to three decimal places.

Default R-values/U-values in Appendix H

Appendix H contains pre-calculated Form 3Rs for a number of standard assemblies. The Total R-values and U-values from these assemblies must be used in compliance calculations unless a Form 3R is completed for the actual proposed assembly, or unless the compliance approach only uses the insulation level alone. Tables G-12 through G-16 summarize these default U-values.

Appendix H also includes Form 3Rs for assemblies that meet the default U-values with a combination of batt and rigid insulation, rather than only batt insulation (including metal frame assemblies). In addition, it contains R-values and other information on a variety of masonry wall assemblies.

To determine if an assembly meets the minimum insulation levels required by the mandatory measures or the prescriptive packages, obtain the U-value of the proposed assembly or complete a Form 3R for a wood frame assembly and see if the proposed U-value is less than or equal to the standard U-value for that assembly type and insulation level as listed in Tables G-12 through G-15. Compare the proposed U-value to the U-values listed for framing spacing of 16" o.c. for walls and 24".o.c. for roofs/ ceilings.

HOW TO COMPLETE FORM 3R

The U-value and R-value of a proposed construction assembly is calculated on Form 3R (a blank copy of Form 3R is contained in Appendix A). The form is used in documenting compliance and design load calculations (see *Compliance Documentation*).

Form 3R uses the parallel path method for determining the overall U-value of wood framed assemblies. This entails calculating the total R-value of the assembly through both the cavity between framing and through the frame material itself, and then calculating the area-weighted U-value for the assembly overall.

NOTE:

U-values for metal frame walls are not calculated using the parallel path method, but instead are determined using a method based on the zonal method in the 1993 *ASHRAE Handbook of Fundamentals* or manufacturers' data (see Appendix H or Chapter 2, Part 2.3 for more information). Pre-calculated default U-values for metal frame walls may also be used in compliance calculations. These are listed in Table G-18.

Figures G-7 and G-8 are examples of completed Form 3Rs. The general steps for completing a Form 3R are listed below:

Parallel Path Method

1. List the Assembly *Name* (e.g., "Flat Ceiling"), Assembly *Type* (e.g., Wall, Roof, Floor), Framing *Material* (e.g., Wood or Metal), Framing *Size* (e.g., 2x6), Framing *Spacing* (e.g., 16" o.c.) and Framing % (from Table G-6). If a prescriptive package is being used to show compliance and the assembly is a wall, list the wall weight per square foot.

2. Identify the appropriate R-values for Outside and Inside Air Films according to the standard values listed in Table G-7 for winter conditions. An inside film may be assumed on both sides of the assembly when the heated space is adjacent to an enclosed, unconditioned space. List these numbers in both the Cavity R-Value and Frame R-Value columns of Form 3R.

IMPORTANT NOTE:

***Do not round any of the values used on Form 3R** except for the final resulting Total R-Value shown in Step 7 below.*

Air film R-values may also be taken from ASHRAE Table 1, Surface Conductances for Air, in Appendix B. The STILL AIR value is the inside film and the MOVING AIR value is the outside film.

3. Starting with the outside material, identify the type and thickness of each construction assembly component, including air spaces (see *Attic and Crawlspace R-values* below), and list them on successive lines under "List of Construction Components."

Table G-6: Framing Percentages

Assembly Type	Framing Spacing	Framing Percentage
WALLS	16"o.c.	15 %
	24"o.c.	12 %
	48"o.c.	9 %
FLOORS	16"o.c.	10 %
	24"o.c.	7 %
ROOFS	16"o.c.	10 %
	24"o.c.	7 %
	48"o.c.	4 %

4. For each component, find the associated Resistance (R) from ASHRAE Table 2, Thermal Resistance of Plane Air Spaces, and Table 4, Thermal Properties of Typical Building and Insulating Materials - Design Values, found in Appendix B. ***When a range of ASHRAE values is listed for a material, use the most conservative assumption for compliance with the standards*** (i.e., the lowest R-value or the highest U-value). Typical R-values for unframed air spaces are listed in Table G-7. Manufacturers' rated R-values may be used in lieu of ASHRAE values. For insulation or air spaces penetrated by wood framing, both the insulation or air space and the framing itself should be listed.

Table G-7: Standard R-Values for Air Films and Air Spaces[1]

	Wall	Roof		Floor
		Flat[3]	45º angle[4]	
AIR FILMS[2]				
Inside	0.68	0.61	0.62	0.92
Outside	0.17	0.17	0.17	0.17
AIR SPACES[5]				
0.5 inch	0.77	0.73	0.76	0.77
0.75 inch	0.84	0.75	0.81	0.85
1.5 inch	0.87	0.77	0.80	0.94
2.0 inch	0.875	0.778	0.805	0.955
2.5 inch	0.86	0.785	0.81	0.97
3.5 inch[6]	0.85	0.80	0.82	1.00

[1] Values from *ASHRAE Handbook of Fundamentals*, 1993 edition, Chapter 24, Tables 1, 2 and 3 reprinted in Appendix B of this manual.

[2] Assumes a non-reflective surface emittance of 0.90 and winter heat flow direction.

[3] Use the "Flat" roof R-values for roof angles between horizontal and 22 degrees.

[4] Use the "45 degree" roof R-values for roof angles between 23 and 60 degrees.

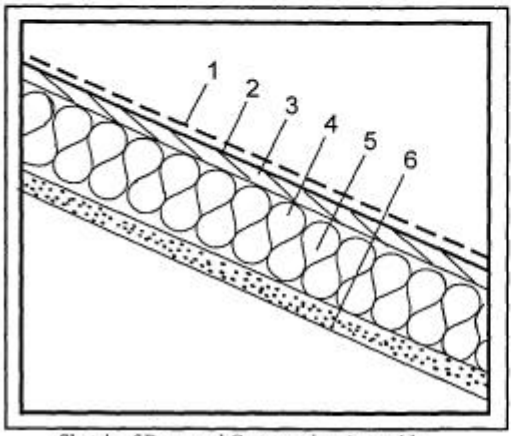
[5] Assumes mean temperature of 90ºF, temperature difference of 10ºF, surface emittance of 0.82 and winter heat flow direction.

[6] Use these R-values for air spaces greater than or equal to 3.5 inches, such as attics.

PROPOSED CONSTRUCTION ASSEMBLY: RESIDENTIAL — FORM 3R

Smith Residence — Project Title
July 1, 1999 — Date
123 main Street, Sacramento, CA — Project Address
Mary Jones — Documentation Author
(916) 555-0000 — Telephone
R-30 Roof — Assembly Name

Building Permit #
Plan Check / Date
Field Check / Date
Enforcement Agency Use Only



Sketch of Proposed Construction Assembly

Assembly Type: (check one) ___ Floor; ___ Wall; ✓ Ceiling/Roof

Framing Material: Wood

Framing Size: 2 × 10

Framing Spacing: 16 inches on center (" o.c.)

Framing Percentage (Fr.%): (check one)

Wall: ___ 15% (16" o.c.); ___ 12% (24" o.c.); ___ 9% (48" o.c.)

Floor/Ceiling: ✓ 10% (16" o.c.); ___ 7% (24" o.c.); ___ 4% (48" o.c.)

Wall Weight / sf: N/A (Packages only)

List of Construction Components

		R-Value Cavity (R_c)	R-Value Frame (R_f)
	Outside Surface Air Film	0.170	0.170
1.	Asphalt shingle roofing	0.440	0.440
2.	Building paper (felt)	0.060	0.060
3.	0.50 in plywood	0.620	0.620
4.	2x10 in fir framing	—	9.158
5.	R-30c fiberglass insulation (8.5" thkns)	30.000	—
6.	0.50 in gypsum or plasterboard	0.450	0.450
7.			
8.			
	Inside Surface Air Film	0.610	0.610
	Total Unadjusted R-Values:	32.350 (R_c)	11.508 (R_f)

Framing Adjustment Calculation:

$$[(\underset{1 \div R_c}{1/32.350}) \times (\underset{1-(Fr.\% \div 100)}{1-10/100})] + [(\underset{1 \div R_f}{1/11.508}) \times (\underset{Fr.\% \div 100}{10/100})] = \underset{\text{Total U-Value}}{0.036}$$

$$\underset{1 \div \text{Total U-Value}}{1/0.036} = \underset{\text{Total R-Value}}{27.778}$$

July 1, 1999

Figure G-7: Form 3R Roof/Ceiling Assembly

PROPOSED CONSTRUCTION ASSEMBLY: RESIDENTIAL — FORM 3R

Smith Residence
Project Title

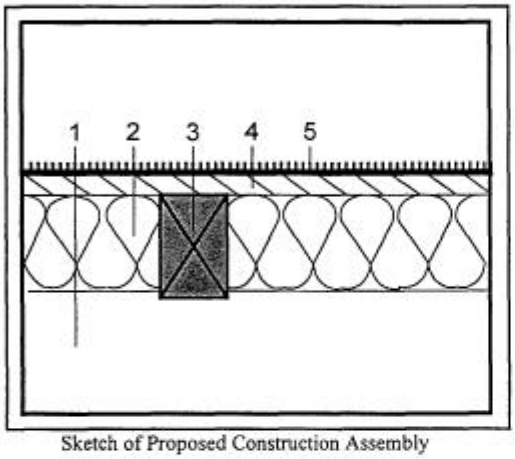
July 1, 1999
Date

123 Main Street, Sacramento, CA
Project Address

Mary Jones (916) 555-0000
Documentation Author — Telephone

R-19 Raised Floor
Assembly Name

Building Permit #
Plan Check / Date
Field Check / Date
Enforcement Agency Use Only



Sketch of Proposed Construction Assembly

Assembly Type: (check one)
- ✓ Floor
- ___ Wall
- ___ Ceiling/Roof

Framing Material: Wood
Framing Size: 2 × 8
Framing Spacing: 16 inches on center (" o.c.)
Framing Percentage (Fr.%): (check one)

Wall:
- ___ 15% (16" o.c.)
- ___ 12% (24" o.c.)
- ___ 9% (48" o.c.)

Floor/Ceiling:
- ✓ 10% (16" o.c.)
- ___ 7% (24" o.c.)
- ___ 4% (48" o.c.)

Wall Weight / sf: NA
(Packages only)

List of Construction Components

		R-Value Cavity (R_c)	R-Value Frame (R_f)
	Outside Surface Air Film	0.170	0.170
1.	Effective R-value of vented crawlspace	6.000	6.000
2.	R-19 fiberglass insulation	19.000	—
3.	7.25 in fir framing	—	7.178
4.	0.625 in plywood	0.770	0.770
5.	Carpet & Pad	2.080	2.080
6.			
7.			
8.			
	Inside Surface Air Film	0.920	0.920
	Total Unadjusted R-Values:	28.940 (R_c)	17.118 (R_f)

Framing Adjustment Calculation:

$$\left[\left(\frac{1}{14.535}\right) \times \left(\frac{1-10/100}{1-(\text{Fr.\%} \div 100)}\right)\right] + \left[\left(\frac{1}{17.118}\right) \times \left(\frac{10/100}{\text{Fr.\%} \div 100}\right)\right] = 0.037 \text{ Total U-Value}$$

$$\frac{1}{0.037} = 27.027 \text{ Total R-Value}$$

(1 ÷ Total U-Value)

July 1, 1999

Figure G-8: Form 3R Floor Assembly

NOTE:

Any carpet and pad combination must be assigned an R-value of R-2.0. Do not use ASHRAE R-values for carpet and pad.

5. List the insulation R-value for batt insulation in the Cavity (R_C) column and the R-value of the wood framing in the Frame (R_f) column. The R-values of all other components (not penetrated by the framing) should be listed in both columns.

6. Add up the R-values in the Cavity (R_C) column and in the Frame (R_f) column. Enter these as the "Total Unadjusted R-Values."

7. Calculate the following values and enter the results in the “Framing Adjustment Calculation”:

    - $1/R_C$
    - 1 - (Framing %/100)
    - $1/R_f$
    - Framing %/100

Complete the arithmetic to obtain the "Total U-Value". Round the Total U-Value to three significant digits (i.e., 0.06554 rounds to 0.066). Then divide 1 by the Total U-Value to obtain the Total R-Value. Round the Total R-Value to two significant digits.

Attic and Crawl Space R-Values

Attic air spaces greater than or equal to 3.5 inches shall be treated as standard 3.5 inch air spaces in a roof assembly. The appropriate R-values for flat and 45 degree roofs are listed in Table G-7. The "Flat" R-value should be used for roof angles between horizontal and 22 degrees, while the "45 degree" R-value applies to roof angles between 23 and 60 degrees. See also Figure G-7 for an example of an attic air space.

Vented crawl spaces shall be assigned a fixed R-value of R-6. See Figure G-8 for an example of a vented crawl space.

Simplified Masonry U-Value Calculation in Appendix H

Appendix H contains an alternative, simplified approach to determine R-values, U-values and heat capacities for masonry and concrete walls. See Appendix H for details and instructions.

See also *Insulation R-Value* and *U-Value*.

SEER (Seasonal Energy Efficiency Ratio)

The total cooling of a central air conditioner or heat pump in Btu during 12 months divided by the total electric energy input in watt-hours during the same period.

The Seasonal Energy Efficiency Ratio of all new central air conditioners and central air source heat pumps with output less than 65,000 Btuh manufactured on or after January 1, 1993 shall be certified not to be less than the values listed as follows:

Appliance	*SEER*
Central Air Conditioners	
Split System	10.0
Single Package	9.7
Central Air Source Heat Pumps	
Split System	10.0
Single Package	9.7

See also *Heating, Ventilating and Air Conditioning* and *EER*.

Service Water Heating

"Service water heating is heating of water for sanitary purposes for human occupancy, other than for comfort heating." [*EES*, Section 101]

Shading

The effectiveness of a fenestration product plus shade assembly in stopping heat gain from solar radiation is expressed as the Solar Heat Gain Coefficient (SHGC). SHGC values range from 0 to almost 1. The more effective at stopping heat gain, the lower the SHGC value. See also *Solar Heat Gain Coefficient.*

See Tables G-8 G-9, and G-10 for allowed SHGCs.

Shading Coefficient (SC)

See *Shading*, *Solar Heat Gain Coefficient*.

Solar Heat Gain Coefficient (SHGC)

"Solar heat gain coefficient (SHGC) is the ratio of the solar heat gain entering the space through the fenestration area to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted, or convected into the space." [*EES*, Section 101]

Controlling heat gain from solar radiation is an integral element of the standards and therefore must be taken into account for compliance purposes. Within the context of the standards, there are different options for selecting appropriate SHGCs.

Solar Heat Gain Coefficient (SHGC) replaces the Shading Coefficient (SC) used in earlier versions of the standards as a measure of the solar heat gain due to windows and shading devioces.

SHGC Compliance Options - Performance Compliance

- The SHGC for the fenestration is determined based on the default table glass type and framing from Table G-8 or from product literature for NFRC-certified products.

- When glazing is used in combination with interior or exterior shades, the solar heat gain coefficient for the fenestration assembly is based on values from Tables G-9 and G-10.

Internally, approved computer programs must calculate the SHGC of a window with an interior *shade open* and *shade closed*. Generally, glazing is assumed to be unshaded (Shade Open) during the winter period when solar gains can contribute to building energy needs and shaded (Shade Closed) during the summer period when solar gains are undesirable. However, these values are not reported to the user.

NOTE:

Approved computer programs calculate the solar heat gain coefficient automatically, based on the solar heat gain coefficient of the fenestration ($SHGC_{fen}$), the interior shade selected, the exterior shade selected and any overhangs (see Tables G-8 to G-10 or manufacturer's literature). Refer to the User's Manual for each program for specific input requirements.

SHGC Compliance Options - Prescriptive Compliance

- The SHGC is determined based on the default table glass type and framing from Table G-8 or from product literature for labeled products. Interior shading is not credited in the prescriptive approach.

- When glazing is used in combination with an exterior shading device, the solar heat gain coefficient is calculated using Form S. See Chapter 3

Solar Heat Gain Coefficient of Clear Glass with No Shading or Standard Drapes and/or Bug Screens

If no shading device is specified and if no special glazing type is to be installed, the designer must assume in performance compliance calculations that:

- Single pane clear glazing has an $SHGC_{fen}$ of 0.80 with metal framing or 0.74 with vinyl or wood framing.

- Double pane clear glazing has an $SHGC_{fen}$ of 0.70 with metal framing or 0.65 with vinyl or wood framing.

- In the performance approach, the window is modeled with draperies and bugscreens unless different interior and exterior shading attachments are selected from a list of allowed devices. Except for skylights some type of interior and exterior shading device must be modeled. Custom interior or exterior attachments are not allowed to be modeled.

Solar Heat Gain Coefficients from Manufacturer's Literature

Manufacturer's data for a labeled fenestration product may be used directly in compliance calculations, if applicable, or for $SHGC_{fen}$ as part of the overall SHGC calculations on the *Solar Heat Gain Coefficient Worksheet* (Form S) for determining compliance with the prescriptive packages in Chapter 3.

Table G-8: DEFAULT SOLAR HEAT GAIN COEFFICIENT

Frame Type	Product	Glazing	Total Window SHGC Single Pane	Total Window SHGC Double Pane
Metal	Operable	Uncoated	0.80	0.70
Metal	Fixed	Uncoated	0.83	0.73
Metal	Operable	Tinted	0.67	0.59
Metal	Fixed	Tinted	0.68	0.60
Metal, Thermal Break	Operable	Uncoated	0.72	0.63
Metal, Thermal Break	Fixed	Uncoated	0.78	0.69
Metal, Thermal Break	Operable	Tinted	0.60	0.53
Metal, Thermal Break	Fixed	Tinted	0.65	0.57
Non-Metal	Operable	Uncoated	0.74	0.65
Non-Metal	Fixed	Uncoated	0.76	0.67
Non-Metal	Operable	Tinted	0.60	0.53
Non-Metal	Fixed	Tinted	0.63	0.55

SHGC = Solar Heat Gain Coefficient

Table G-9: SHGC's FOR ALLOWED INTERIOR SHADING ATTACHMENTS[1]

Interior Shading Attachment/Device	SHGC Before Jan. 1, 2002	SHGC On or After Jan. 1, 2002
Standard *includes Draperies (all colors & weaves), None (for non-skylights),or Translucent Roller Shades (all colors) Standard* values are also used for any interior shading device not otherwise listed in this table.	0.68	0.68
Blinds *All Colors of Venetian Blinds, Miniblinds, or Vertical Blinds.*	0.47	0.47
OpRollShd Opaque Roller Shades (All Colors)	0.47	0.47
None Only Allowed for Skylights. Also the default value for skylights when no other interior shading is specified.	1.00	1.00

[1] Shading devices between glazing lights for vertical windows or skylights may be modeled as an interior shading device or interior shading attachment of the same type.

Calculating Solar Heat Gain Coefficients Using Form S

If using a prescriptive alternative component package for compliance, use values from Table G-8 or manufactuer's literature for the $SHGC_{fen}$ value for a labeled fenestration product. If an exterior shading device is planned, the SHGC may be calculated using the *Solar Heat Gain Coefficient (SHGC) Worksheet* (Form S). The *Solar Heat Gain Coefficient Worksheet* incorporates the following basic formula for calculating a combined SHGC:

$SHGC_{comb} = [(0.2875 \times SHGC_{max}) + 0.75] \times SHGC_{min}$

Where:

$SHGC_{comb}$ = Combined solar heat gain coefficient
$SHGC_{max}$ = Maximum solar heat gain coefficient
$SHGC_{min}$ = Minimum solar heat gain coefficient

The *Solar Heat Gain Coefficient Worksheet* allows the calculation of SHGC for both simple and complex shade combinations.

The following sections explain how to calculate solar heat gain coefficients Form S. The number of each item below corresponds to the appropriate item on Form S.

General Information

Enter either:

1a. For products with NFRC testing and labels, enter the product's labeled SHGC as #1a. $SHGC_{fen}$.

OR enter

1b,. The default $SHGC_{fen}$ from Table S-1 (or Table G-8) corresponding to the fenestration characteristics described in entries 1c, 1d, 1e, and 1f. Entries for 1c, 1d, 1e, and 1f are only needed if 1b is entered for $SHGC_{fen}$.

If 1b. is entered then:

1c. Describe the Frame Type [metal, metal w/thermal break, or non-metal (non-metal includes both vinyl and wood)].
1d. The Product Type (operable or fixed);
1e. The Glazing Type (tinted or uncoated); Note that tints or coatings that cannot be easily observed by the building official must be classified as "uncoated", that is, tints must be easily visible to the naked eye.
1f. Single or Double pane glazing.

2. For skylights mounted on a roof surface with a pitch less than or equal to 1 in 12 (as defined for the residential standards) enter "Y", other wise enter "N."

   Note: For the purpose of complying with prescriptive packages, skylights mounted on roof surfaces with pitchs greater than 1 in 12 are treated as **vertical windows** facing the direction of the outward normal to the roof for purposes of complying with the residential standards. Hence in climate zone 14, a skylight on a 4 in 12 roof facing east or west is required to have a fenestration SHGC of 0.40 or a combined SHGC of 0.39.

   In a performance compliance, if no interior shades are proposed, select *Standard* or *Draperies* . Note that this requirement does not apply to skylights. For skylights select *Standard* or *None*. The $SHGC_{Interior\ Shade}$ for skylights without interior shades equals 1.0 and is the default value.)

Complete steps 3 through 4 for any exterior shades.

Exterior Shade

Complete steps 1 and 2 for the fenestration product. Using these values, continue with steps 3 and 4.

3. Describe the exterior shading device in the space provided (e.g., roll down awning). List $SHGC_{Exterior\ Shade}$, the SHGC of the exterior shade with 1/8" clear single pane glass and metal framing, from Table S-2 or G-8. If a single window or skylight has multiple exterior shades (i.e. shade screens and

awnings) use the one shading device with the lower SHGC.

If no exterior shade is proposed, assume standard bug screens with a SHGC of 0.76 (or an SHGC of 1.00 for horizontal glazing). This applies to the full area of fixed fenestration products as well as operable.

4. Calculate $SHGC_{Shade\ Open}$ using values from Items 3 and either 1a or 1b. The result is the combined SHGC of the fenestration product and exterior device with the interior *shade open*.

Table G-10: Solar Heat Gain Coefficients Used for Form S and Computer Performance Methods [1,2]

Exterior Shading Attachment/Device[3]	SHGC[4]
1) Standard Bug Screens	0.76
2) Exterior Sunscreens with weave 53*16/inch	0.30
3) Louvered Sunscreens w/louvers as wide as openings	0.27
4) Low Sun Angle (LSA) Louvered Sunscreens	0.13
5) Roll-down Awning	0.13
6) Roll Down Blinds or Slats	0.13
7) None (for skylights only)	1.00

1. These values may be used on line 11 of the Solar Heat Gain Coefficient Worksheet (form S) to calculate exterior shading with other glazing types and combined interior and exterior shading with glazing.

2. Exterior operable awnings (canvas, plastic or metal), except those that roll vertically down and cover the entire window, should be treated as overhangs for purposes of compliance with the Standards.

3. Standard bug screens must be assumed for all fenestration unless replaced by other exterior shade screens. The solar heat gain coefficient listed for bug screens is an area-weighted value that assumes that the screens are only on operable windows. The solar heat gain coefficient of any other exterior shade screens applied only to some window areas must be area-weighted with the solar heat gain coefficient of standard bug screens for all other glazing (see Weighted Averaging in the Glossary). Different shading conditions may also be modeled explicitly in the computer performance method.
4. Reference glass for determining solar heat gain coefficients is 1/8 inch double strength (DSS) glass.

$SHGC_{fen}$ (from either 1a. or 1b.) and the types of interior and exterior shading attachments are used directly on the Certificate of Compliance (CF-1R) for the prescriptive packages.

Overhangs

Overhang shading is modeled explicitly in the computer performance method.

Overhang requirements for the prescriptive packages are specified in the standards. Other than as specified in the standards, overhang shading may not be included in the SHGCs used to meet the minimum prescriptive requirements.

Shading by Adjacent Structures or Terrain or other Permanent Obstructions

Fenestration may be considered *substantially shaded* if a permanent obstruction is substantially wider than the fenestration being considered and if the obstruction is tall enough to shade the top of the fenestration at a profile angle of 45 degrees. If fenestration is substantially shaded in the summer and winter

by a permanent obstruction, the glazing may be treated as having a permanently fixed exterior SHGC of 0.20 for compliance calculations.

It is up to the local enforcement agency to determine whether the shading elements are sufficiently permanent and meet the criteria.

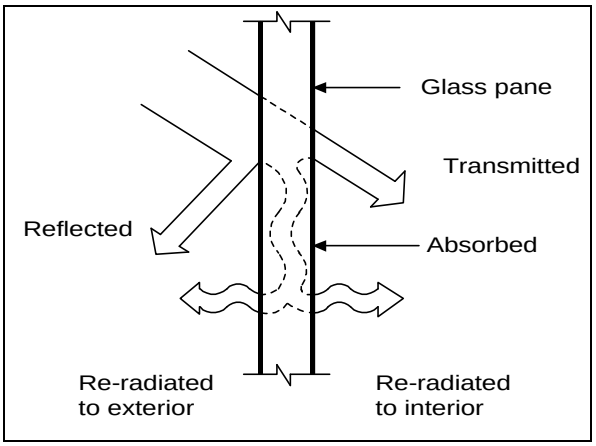


Figure G-9: Solar Radiation through Glass

Side Fins

Vertical shading elements mounted on either side of a glazed opening that can protect the glazing from lateral low angle sun penetration.

Single Family Attached

A multi-family building whose dwelling units share common walls but do not share any common floors/ceilings is considered Single Family Attached.

See *Building Type*.

Single Family Building

A single dwelling unit of occupancy type R, as defined in the *UBC*, which stands separate and unattached from other dwelling units, but may have an attached garage. A dwelling unit that is separated only by a property line and double wall construction (with a space between the walls) from another dwelling unit and that shares no common floor/ceiling is also treated as single family.

Skylight

A skylight is "glazing having a slope less than 60 degrees from the horizontal with conditioned space below, except for purposes of complying with Section 151(f) [prescriptive packages], where a skylight is glazing having a slope not exceeding 4.76 degrees (1:12) from the horizontal." [EES, Section 101]

See also *Fenestration Product, Glazing*.

Slab-on-Grade

A slab-on-grade is an exterior concrete floor in direct contact with the earth below the building.

See Chapters 3 and 5, and the *Glossary* definitions of *Conditioned Footprint Area* and *Exterior Floor*.

Solar Heat Gain Coefficient (SHGC)

The solar heat gain coefficient is a measure of the effectiveness of a fenestration product or window covering to stop solar gains through the window. Solar heat gain coefficient (SHGC) is the "ratio of the solar heat gain entering the space through the fenestration area to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted, or convected into the space." [EES, Section 101]

See *Shading* for information on compliance with the standards.

Source Energy

Source energy is the original energy consumed to produce usable end-use energy for space conditioning, lighting, appliances and other uses in a building. The standards are based on the concept of an annual energy budget that measures source energy used per year in a building.

Source energy accounts for all of the energy used in delivering energy to the building site including power generation, transmission losses and distribution. Electricity (kWh) is converted to source energy (Btu) at the rate of 10,239 Btu per kilowatt-hour (3 times 3,413). This assumes that only a third of the energy used to produce electricity is actually delivered to a building in a usable form.

By contrast, fossil fuels such as natural gas, propane and oil may be used directly at the

building site, so that source energy equals end-use energy. Natural gas used directly at the building site is converted to source energy at the rate of 100,000 Btu per therm.

Table G-11: Source Energy Conversion Rates[1]

Energy Source	Btu per unit consumption
Electricity	10,239 Btu/kilowatt-hour
Natural Gas	100,000 Btu/therm
Fuel Oil	138,400 Btu/gallon
LPG (Propane)	91,080 Btu/gallon

[1] Reprinted from EES, Section 102, Table 1-B.

See *Energy Budget* and *Heating, Ventilating and Air Conditioning (Electric Resistance Heating)*.

South-Facing

"South-facing is oriented to within 45 degrees of true south, including 45°0'0" west of south (SW), but excluding 45°0'0" east of south (SE)." [*EES*, Section 101]

This definition applies only to the prescriptive packages and master plans analyzed according to the multiple orientation alternative as explained in Chapter 8, Part 8.4. In the computer methods the actual building orientation must be used, except in the case of master plans as stated above.

The designation “South-Facing” is also used in production buildings using orientation restrictions (e.g., Shaded Areas: East-Facing). See Chapter 8, Part 8.4.

Space Conditioning System

A space conditioning system is “a system that provides . . . heating, ventilating, or cooling within or associated with conditioned spaces in a building." [*EES*, Section 101] The system may operate alone or in conjunction with other systems.

See *Heating, Ventilating, and Air Conditioning*.

Stairs

See *Conditioned Floor Area*.

Standard Design

A new building or addition alone (see Chapter 7, Part 7.2) complies with the standards if the predicted source energy use of the proposed design is the same or less than the annual budget for space conditioning and water heating of the standard design. For both slab-on-grade and raised floor buildings, the standard design is based on the conservation levels and features in prescriptive Package D.

See *Source Energy, Energy Budget* and *Proposed Design*, and Chapter 4, Part 4.2.

Standards

The California *Energy Efficiency Standards* as set forth in the *California Code of Regulations*, Title 24, Part 6.

Standby Loss

Standby loss is the ratio of heat lost per hour to the heat content of the stored water above room temperature. It is one of the measures of efficiency of water heaters required for water heating energy calculations for some types of water heaters (see Chapter 5). Standby loss is expressed as a percentage. [*AER*, Section 1602]

Subordinate Occupancy

In mixed occupancy buildings, any occupancy type that is not the dominant occupancy. See also *Dominant Occupancy, Mixed Occupancy,* and Chapter 8.

System

A system is “a combination of equipment, controls, accessories, interconnecting means, or terminal elements, by which energy is transformed to perform a specific function, such as space conditioning, service water heating, or lighting." [*EES*, Section 101]

Task Oriented Lighting

Task lighting is “lighting that is designed specifically to illuminate a task location, and that is generally confined to the task location." [*EES*, Section 101]

See also *Lighting*, *General Lighting*, Chapter 2, Part 2.4, Figures 2-8 and 2-9.

Thermal Mass

"Thermal mass is solid or liquid material used to store heat for later heating use or for reducing cooling requirements." [*EES*, Section 101]

Commonly used thermal mass materials include concrete, masonry, brick, tile, rock and water. These materials are readily available and have excellent thermal properties. The more mass a building has, the slower its interior temperatures will change.

Thermal mass can conserve energy in a residential building in two basic ways:

- In the winter, solar radiation entering a building through glass is absorbed directly or indirectly into areas of thermal mass exposed to indoor air. The mass material tends to store its heat during the day and release it into the room air during the evening and night when more heating is required.

Table G-12: Thermal Mass Properties

Material	Conductivity (Btu/hr-ft^2-^{o}F)	Density (lb/ft^3)	Specific Heat (Btu/lb-^{o}F)
Adobe	**0.33**	**120**	**0.20**
Heavy Concrete	**0.98**	**140**	**0.20**
Lightweight Concrete	**0.36**	**85**	**0.20**
Gypsum	**0.09**	**50**	**0.26**
Masonry Veneer	**0.62**	**127**	**0.20**
Masonry Infill	**0.44**	**120**	**0.20**
Concrete Masonry Unit	**0.59**	**105**	**0.20**
Grouted Concrete Masonry Unit	**1.00**	**134**	**0.20**
Stucco	**0.47**	**105**	**0.20**
Tile in Mortar	**0.67**	**120**	**0.20**
Solid Wood (Fir)	**0.07**	**32**	**0.33**

Table G-13: Thermal Mass Coverings and Associated Categories[1]

Category 1: Acceptable as Exposed Mass In Any Location. Floor coverings/surfaces determined to be acceptable on any portion of a slab designated as thermal mass in any location within the conditioned space of a residential building.

Category 2: Acceptable as Exposed Mass Only In Kitchens, Dining Areas that are Extensions to Kitchens, Pantries, Bathrooms, Laundry Rooms, Service Porches and/or Entries. Concrete slabs with Category 2 surfaces must be treated as covered slab in other locations.

Covering/Surface	Category
Brick	1
Concrete, Exposed Aggregate	1
Concrete, Painted and/or Polished	2
Concrete, Stamped	1
Concrete, Unfinished	2
Hardwood Veneer (except when installed on wood sleepers)	1
Resin-based Poured Flooring	2
Stone or Stone Veneer	1
Sheet Vinyl	2
Tile, Asphalt	2
Tile, Ceramic	1
Tile, Terrazzo	1
Tile, Vinyl	2
Tile, Vinyl-Asbestos	2
Other Masonry Materials with Permanent Finishes Similar to Those Specified in Category 1 and Acceptable to the Building Official	1

1. The intent of these guidelines is to prevent taking exposed thermal mass credit for floor materials that are likely to be covered with carpeting at the time of building occupancy.

   Building officials should allow flexibility for building designs that include radiant floor heating systems and/or that incorporate large areas of uncarpeted slabs in conjunction with south facing glazing as an integral component of deliberately designed passive solar structures.

- In the summer months, the mass material can be cooled down at night by natural ventilation. During the daytime, the mass absorbs excess heat and helps keep down indoor air temperatures. If glazing is well shaded to keep out direct sunlight, the mass can substantially reduce or eliminate completely the need for mechanical cooling.

The standards specify thermal mass materials as including, but not limited to:

- Hard-surfaced slab floors
- Masonry walls and fireplaces
- Gypsum board walls and ceilings in excess of 1/2 inch thickness

The physical properties of thermal mass materials are listed in Table G-12.

Table G-13 lists recommendations on when it is appropriate to take credit for a particular mass material. The intent of these guidelines is to prevent taking thermal mass credit for floor materials that are likely to be covered with carpeting at the time of building occupancy.

Building officials should allow flexibility for building designs that include radiant floor heating systems and/or that incorporate large areas of uncarpeted slabs in conjunction with south facing glazing as an integral component of deliberately designed passive solar structures.

Title 24

The *State Building Code*, published in Title 24 of the *California Code of Regulations*. The *Energy Efficiency Standards* are contained in Part 6. Part 1 includes the administrative requirements of the standards.

Table G-14: Standard U-Values of Wood Frame Roofs and Ceilings[1]

Ceiling Insul.	Framing Spacing	Reference Name[2]	U-Value
R-0[3]	16" o.c.	R.0.2X6.16	0.298
R-0[3]	24" o.c.	R.0.2X4.24[4]	0.306
R-11[3]	16" o.c.	R.11.2X6.16	0.077
R-11[3]	24" o.c.	R.11.2X4.24	0.077
R-13[3]	16" o.c.	R.13.2X6.16	0.069
R-13[3]	24" o.c.	R.13.2X4.24	0.069
R-19	16" o.c.	R.19.2X8.16	0.051
R-19	24" o.c.	R.19.2X4.24	0.047
R-22	16" o.c.	R.22.2X10.16	0.045
R-22	24" o.c.	R.22.2X4.24	0.041
R-30	16" o.c.	R.30.2X10.16	0.036
R-30	16" o.c.	R.30.2X12.16	0.034
R-30	24" o.c.	R.30.2X4.24	0.031
R-38	16" o.c.	R.38.2X12.16	0.030
R-38	16" o.c.	R.38.2X14.16	0.028
R-38	24" o.c.	R.38.2X4.24	0.024
R-49	16" o.c.	R.49.2X4.16	0.019
R-49	24" o.c.	R.49.2X4.24	0.019

1. Based on ASHRAE Parallel Heat Flow Calculation, 1993 *ASHRAE Handbook of Fundamentals*.
2. The names given to the standard assemblies used to calculate these U-values in Appendix H.
3. Does not meet the minimum level required as a mandatory measure (see Chapter 2, Part 2.2).
4. Roof/ceiling assemblies whose reference names list 2X4 framing include an attic space.

U-value

The U-value is the "overall coefficient of thermal transmittance of a construction assembly, in Btu/(hr x ft^2 x ºF), including air film resistances at both surfaces." [*EES*, Section 101]

The standard U-values listed in Tables G-12 through G-15 must be used for wood frame assemblies unless a Form 3R is completed as explained under R-value. Appendix H contains completed Form 3Rs for each standard

assembly. If insulation level and framing material are known, but no other information is available on the assembly, use the worst case (highest) standard U-value for the insulation level. For wall and roof/ceiling assemblies, this corresponds to framing at 16 inch o.c.

Table G-15: Standard U-Values of Wood Frame Walls[1]

Insul.	Wall Spacing	Framing Name[2]	Reference U-Value
R-0[3]	16" o.c.	W.0.2X4.16	0.385
R-0[3]	24" o.c.	W.0.2X4.24	0.393
R-7[3]	16" o.c.	W.7.2X4.16	0.130
R-7[3]	24" o.c.	W.7.2X4.24	0.127
R-11[3]	16" o.c.	W.11.2X4.16	0.098
R-11[3]	24" o.c.	W.11.2X4.24	0.094
R-13	16" o.c.	W.13.2X4.16	0.088
R-13	24" o.c.	W.13.2X4.24	0.085
R-15	16" o.c.	W.15.2X4.16	0.081
R-15	24" o.c.	W.15.2X4.24	0.077
R-19	16" o.c.	W.19.2X6.16	0.065
R-19	24" o.c.	W.19.2X6.24	0.063
R-21	16" o.c.	W.21.2X6.16	0.059
R-21	24" o.c.	W.21.2X6.24	0.056
R-25	16" o.c.	W.25.2X6.16	0.046
R-29	16" o.c.	W.29.2X4.16	0.035
Solid core wood door (no insulation)		D.O.SCW	0.330

1. Based on ASHRAE Parallel Heat Flow Calculation, 1993 *ASHRAE Handbook of Fundamentals*.
2. The names given to the standard assemblies used to calculate these U-values in Appendix H.
3. Does not meet the minimum level required as a mandatory measure (see Chapter 2, Part 2.2).

NOTE:
Table G-18 lists standard U-values for steel frame walls. These values must be used in compliance calculation unless the U-value of the proposed steel frame wall assembly is determined using the methods indicated in Appendix I.

To determine if an assembly meets the minimum insulation levels required by the mandatory measures or the prescriptive packages, complete a Form 3R (for wood frame assemblies) and see if the proposed U-value is less than or equal to the standard U-value for that assembly type and insulation level as listed in Tables G-14 through G-17. Match the standard U-values listed for framing spacing of 16" o.c. for walls and roofs/ceilings.

Table G-16: Standard U-Values of Wood Frame Raised Floors[1]

Floor Insul.	Condition	Reference Name[2]	U-Value
R-0[3]	No C.S.4	FXO.2X6.16	0.241
R-0[3]	With C.S.[4]	FC0.2X6.16	0.097
R-11[3]	No C.S.	FX11.2X6.16	0.071
R-11[3]	With C.S.	FC11.2X6.16	0.050
R-13	No C.S.	FX13.2X6.16	0.064
R-13	With C.S.	FC13.2X6.16	0.046
R-19	No C.S.	FX19.2X8.16	0.049
R-19	With C.S.	FC19.2X8.16	0.037
R-21	No C.S.	FX21.2X8.16	0.045
R-21	With C.S.	FC21.2X8.16	0.035
R-30	No C.S.	FX30.2X10.16	0.034
R-30	With C.S.	FC30.2X10.16	0.028

1. Based on ASHRAE Parallel Heat Flow Calculation, 1993 *ASHRAE Handbook of Fundamentals*.
2. The names given to the standard assemblies used to calculate these U-values in Appendix H.
3. Does not meet the minimum level required as a mandatory measure (see Chapter 2, Part 2.2).
4. No C.S. = No Crawl Space, With C.S. = With Crawl Space

Fenestration U-values measure the thermal transmittance of the entire fenestration product, including the glazing, framing and any dividers. Default fenestration U-values are listed in Tables G-2. See also *Fenestration Product, Insulation R-Value* and *R-Value*.

Table G-17: Standard U-Values of Wood Foam Panel Roofs/Ceilings and Walls[1]

Roof/ Ceiling Insul.	Framing Spacing	Reference Name[2]	U-Value
R-14[3]	48" o.c.	RP.14.2X4.48	0.058
R-22	48" o.c.	RP.22.2X6.48	0.041
R-28	48" o.c.	RP.28.2X8.48	0.033
R-35	48" o.c.	RP.35.2X10.48	0.027
Wall Insul.	**Framing Spacing**	**Reference Name**	**U-Value**
R-14	48" o.c.	WP.14.2X4.48	0.062
R-22	48" o.c.	WP.22.2X6.48	0.044

1. Based on ASHRAE Parallel Heat Flow Calculation, 1993 *ASHRAE Handbook of Fundamentals*.
2. The names given to the standard assemblies used to calculate these U-values in Appendix H.
3. Does not meet the minimum level required as a mandatory measure (see Chapter 2, Part 2.2).

Unconditioned Space

"Unconditioned space is enclosed space within a building that is not conditioned space. . ." [EES, Section 101]

A space is unconditioned if:

- It is not provided with space conditioning;
- It can be isolated from conditioned space by closeable doors; and
- It is not indirectly conditioned.

Common unconditioned spaces include garages, attics, crawl spaces, mechanical closets and sunspaces. Refer to Chapter 5, Part 5.4K for further information concerning modeling unconditioned spaces using approved computer methods.

Table G-18: U-Values of Steel Frame Walls[1]

Cavity Insul.	Sheath. Insul.	Framing Type	Framing Spacing	Reference Name[2]	U-Value[3]
R-11[3]	R-5.25	2x4	16" o.c.	W.11.S2X4.16	0.096
R-11[3]	R-5.25	2x4	24" o.c.	W.11.S2X4.24	0.090
R-13[3]	R-7.0	2x4	16" o.c.	W.13.S2X4.16	0.081
R-13[3]	R-5.25	2x4	24" o.c.	W.13.S2X4.24	0.087
R-15[3]	R-7.0	2x4	16" o.c.	W.15.S2X4.16	0.080
R-15[3]	R-7.0	2x4	24" o.c.	W.15.S2X4.24	0.074
R-19[3]	R-8.75	2x6	16" o.c.	W.19.S2X6.16	0.064
R-19[3]	R-8.75	2x6	24" o.c.	W.19.S2X6.24	0.060
R-21[3]	R-10.5	2x6	16" o.c.	W.21.S2X6.16	0.057
R-21[3]	R-10.5	2x6	24" o.c.	W.21.S2X6.24	0.053

1. Based on ASHRAE Zone Method Calculation, 1993 *ASHRAE Handbook of Fundamentals*.
2. The names given to the standard assemblies used to calculate these U-values in Appendix H.
3. Does not meet the minimum level required as a mandatory measure without sheathing insulation (see Chapter 2, Part 2.2).

Unit Interior Mass Capacity (UIMC)

Unit Interior Mass Capacity (UIMC) is the "amount of effective heat capacity per unit of thermal mass, taking into account the type of mass material, thickness, specific heat, density and surface area." [*EES*, Section 101]

See *Thermal Mass*.

Vapor Barrier

A vapor barrier is "a material with a permeance of one perm or less which provides resistance to the transmission of water vapor." [*EES*, Section 101] Vapor barriers are mandatory in Climate Zones 14 and 16 only.

A vapor barrier is a special covering over framing and insulation that provides extra protection to the insulation from moisture condensation that could destroy it. Vapor barriers are installed on walls only, unless the building has an unvented attic in which case a vapor barrier would also be installed on the ceiling.

A perm is defined as equal to 1 grain of water vapor transmitted per 1 square foot per hour per inch of mercury pressure difference.

See Chapter 2, Part 2.3 for installation information and material specifications. See also *Infiltration Controls* and Chapter 2, Part 2.2.

Ventilation Air

"Ventilation air is that portion of supply air which comes from outside plus any recircuated air that has been treated to maintain the desired quality of air within a designated space." *[EES* (1988), Section 101] Also see Chapter 4 for compliance using mechanical ventilation.

Weatherstripping

Specially designed strips, seals and gaskets attached to doors and windows to prevent infiltration and exfiltration through cracks around the openings. Weatherstripping is one of the mandatory requirements for all new residential construction. See *Infiltration, Exfiltration*, also Chapter 2, Part 2.2.

Weighted Averaging

Whenever two or more types of a building feature, material or construction assembly occur in a building, a weighted average of the different types must be calculated.

Weighted averaging is simply a mathematical technique for combining different amounts of various components into a single number. Weighted averaging is frequently done when there is more than one level of floor, wall, or ceiling insulation in a building, or more than one type of shading device on windows.

Area-weighted R-values are never used; only area weighted U-values.

The formula for weighted averaging (WA) is:

$$WA = \frac{[(\text{Type 1 Area} \times \text{Type 1 Value}) + (\text{Type 2 Area} \times \text{Type 2 Value}) + ..]}{\text{Total Area}}$$

"Area" can be replaced throughout the formula by "Length" or any other unit of measure used for the value being averaged. "Value" can be replaced throughout the formula by "U-value," "Solar Heat Gain Coefficient," "SEER" or any other value which varies throughout a residence and is appropriate to weight average.

NOTE:

It is incorrect to area-weight different R-values. Only U-values can be area-weighted as explained in the *Glossary* discussion of *R-Value*.

West-Facing

"West-facing is oriented to within 45 degrees of true west, including 45°0'0" due north of west (NW) but excluding 45°0'0" south of west (SW)." [*EES*, Section 101]

This definition applies only to the prescriptive packages, and master plans analyzed according to the multiple orientation alternative as explained in Chapter 8, Part 8.4. In the computer methods the actual building orientation must be used, except in the case of master plans as stated above.

The designation “West-Facing” is also used in production buildings using orientation restrictions (e.g., Shaded Areas: West-Facing). See Chapter 8, Part 8.4.

Wood Heater

See Chapter 8, Part 8.6.

Zonal Control

Zonal control refers to the practice of dividing a residence into separately controlled HVAC zones. This may be done by installing multiple HVAC systems that condition a specific part of the building, or by installing one HVAC system with a specially designed distribution system that permits zonal control.

The Energy Commission has approved an exceptional method for analyzing the energy impact of zonally controlled space heating and cooling systems. See Chapter 8, Part 8.8 for a complete explanation of all the criteria.

See also *Zone*.

Zone, Space Conditioning

A space conditioning zone is “a space or group of spaces within a building with sufficiently similar comfort conditioning requirements so that comfort conditions, as specified in ... 150(h) ... can be maintained throughout the zone by a single controlling device.” [EES, Section 101]

G.4 Reprinted Glossary Tables

All tables are reprinted in this section for easy reference.

Table G-1 - Non-Ducted, Non-Central Gas-Fired Heating Equipment

Gas Fired Wall Furnaces, Floor Furnaces and Room Heaters			*AFUE*
Wall	fan type	up to 42,000 Btu/hour	73%
		over 42,000 Btu/hour	74%
	gravity type	up to 10,000 Btu/hour	59%
		over 10,000 Btu/hour up to 12,000 Btu/hour	60%
		over 12,000 Btu/hour up to 15,000 Btu/hour	61%
		over 15,000 Btu/hour up to 19,000 Btu/hour	62%
		over 19,000 Btu/hour up to 27,000 Btu/hour	63%
		over 27,000 Btu/hour up to 46,000 Btu/hour	64%
		over 46,000 Btu/hour	65%
Floor		up to 37,000 Btu/hour	56%
		over 37,000 Btu/hour	57%
Room		up to 18,000 Btu/hour	57%
		over 18,000 Btu/hour up to 20,000 Btu/hour	58%
		over 20,000 Btu/hour up to 27,000 Btu/hour	63%
		over 27,000 Btu/hour up to 46,000 Btu/hour	64%
		over 46,000 Btu/hour	65%

Table G-2: Typical Compliance Forms Needed for Each Compliance Path

Form	Prescriptive Package	Computer Method
CF-1R	Req	Req
MF-1R	Req	Req
C-2R	NA	Req
WS-1R	If App.	NA
WS-2R	If App.	NA
Form 3R	If App.	If App.
Water Heating[3]	If App.	NA
Form S	If App.	If App.
Load Calc.[4]	If App.	If App.
IC-1	Req	Req
CF-4R	NA	If App.
CF-6R	Req	Req

KEY: If App. = If Applicable, Req = Required information, NA = Not Applicable

3 Required for all non-standard water heating systems as defined in Chapter 5, except for Prescriptive Package compliance analyses with water heating systems listed in Table 3-4. Calculations may be on the worksheets which accompany the water heating method (see Chapter 6, Part 6.3). Water heating calculations are automatically included in the approved computer methods so no additional water heating forms are required for those compliance paths.

4 Load calculations must be performed, but need not be submitted unless requested by the local building department.

Table G-3 - Non-Central Space Cooling Equipment

Including Package Terminal Air Conditioners (PTAC); Package Terminal Heat Pumps (PTHP); Room Air Conditioners; and Room Air Conditioner Heat Pumps.

Equipment Type	Size Category (Input)	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure
PTAC (Cooling Mode)	All Capacities	95°F db Outdoor Air	10.0 - (0.16 x Cap/1000)[b] EER	ARI 310/380
		82°F db Outdoor Air	12.2 - (0.20 x Cap/1000)[b] EER	
PTHP (Cooling Mode)	All Capacities	95°F db Outdoor Air	10.0 - (0.16 x Cap/1000)[b] EER	
		82°F db Outdoor Air	12.2 - (0.20 x Cap/1000)[b] EER	
PTHP (Heating Mode)	All Capacities		2.9 - (0.026 x Cap/1000)[b] COP	
Room Air Conditioners, with Louvered Sides	< 6,000 Btu/h		8.0 EER	ANSI/AHAM RAC-1
	≥6,000 Btu/h and < 8,000 Btu/h		8.5 EER	
	≥ 8,000 Btu/h and < 14,000 Btu/h		9.0 EER	
	≥14,000 Btu/h and < 20,000 Btu/h		8.8 EER	
	≥20,000 Btu/h		8.2 EER	
Room Air Conditioners, without Louvered Sides	< 6,000 Btu/h		8.0 EER	
	≥6,000 Btu/h and < 20,000 Btu/h		8.5 EER	
	≥20,000 Btu/h		8.2 EER	
Room Air Conditioner Heat Pumps with Louvered Sides	All Capacities		8.5 EER	
Room Air Conditioner Heat Pumps without Louvered Sides	All Capacities		8.0 EER	
Room Air conditioners & Room Heat Pumps Not Covered by Federal Regulations				
Room Air Conditioners & Heat Pumps	200 volts or more		8.2 EER	10 Code of Federal Regs. Section 430.22(f)
Room Air Conditioners	Less than 200 volts		8.7 EER	
Room Heat Pumps			8.3 EER	

[b] Cap means the rated cooling capacity of the product in Btu/h. If the unit's capacity is less than 7000 Btu/h, use 7000 Btu/h in the calculation. If the unit's capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculation.

[c] Replacement units must be factory labeled as follows: "MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS." Replacement efficiencies apply only to units with existing sleeves less than 16-in. high and less than 42-in. wide.

Table G-4: DEFAULT FENESTRATION PRODUCT U-VALUES

Frame Type[1]	Product Type	Single Pane U-value	Double Pane U-value[2]
Metal	Operable	1.28	0.87
Metal	Fixed	1.19	0.72
Metal	Greenhouse/Garden window	2.26	1.40
Metal	Doors	1.25	0.85
Metal	Skylight	1.72	0.94
Metal, Thermal Break	Operable		0.71
Metal, Thermal Break	Fixed		0.60
Metal, Thermal Break	Greenhouse/Garden window		1.12
Metal, Thermal Break	Doors		0.64
Metal, Thermal Break	Skylight		0.80
Non-Metal	Operable	0.99	0.60
Non-Metal	Fixed	1.04	0.57
Non-Metal	Doors	0.99	0.55
Non-Metal	Greenhouse/Garden windows	1.94	1.06
Non-Metal	Skylight	1.47	0.68

[1] Metal includes any field-fabricated product with metal cladding. Non-metal framed manufactured fenestration products with metal cladding must add 0.04 to the listed U-value. Non-Metal frame types can include metal fasteners, hardware, and door thresholds. Thermal break product design characteristics are:

a. The material used as the thermal break must have a thermal conductivity of not more than 3.6 Btu-inch/hr/ft^2/°F,
b. The thermal break must produce a gap of not less than 0.210", and
c. All metal members of the fenestration product exposed to interior and exterior air must incorporate a thermal break meeting the criteria in (a) and (b) above.

In addition, the fenestration product must be clearly labeled by the manufacturer that it qualifies as a thermally broken product in accordance with this standard.

[2]For all dual glazed fenestration products, adjust the listed U-values as follows:

a. Subtract 0.05 for spacers of 7/16" or wider.
b. Subtract 0.05 for products certified by the manufacturer as low-E glazing.
c. Add 0.05 for products with dividers between panes if spacer is less than 7/16" wide.
e. Add 0.05 to any product with true divided lite (dividers through the panes).

Table G-5: R-Values for Compressed Mineral Fiber Batt Insulation[1]

Standard Compressed R-Value	Nominal Lumber Size	Actual Cavity Depth	R-Value
13 (3.625")	2x4	3.5"	13
19 (6.25")	2x6	5.5"	17.8
22 (6.75")	2x6	5.5"	20
30 (9.5")[2]	2x10	9.25"	30
38 (12")[2]	2x12	11.25"	37

1. Based on manufacturer's data.
2. Note that batt insulation with these R-values is available in smaller thicknesses. R-30 may be achieved with an 8.25" to 8.5" batt, and R-38 may be achieved with a 10.25" to 10.5" batt. If this thinner insulation is used in the framing sizes listed here, the insulation would retain its full rated R-value because it would not be compressed.

Table G-6: Framing Percentages

Assembly Type	Framing Spacing	Framing Percentage
WALLS	16"o.c.	15 %
	24"o.c.	12 %
	48"o.c.	9 %
FLOORS	16"o.c.	10 %
	24"o.c.	7 %
ROOFS	16"o.c.	10 %
	24"o.c.	7 %
	48"o.c.	4 %

Table G-7: Standard R-Values for Air Films and Air Spaces[1]

	Wall	Roof Flat[3]	Roof 45º angle[4]	Floor
AIR FILMS[2]				
Inside	0.68	0.61	0.62	0.92
Outside	0.17	0.17	0.17	0.17
AIR SPACES[5]				
0.5 inch	0.77	0.73	0.76	0.77
0.75 inch	0.84	0.75	0.81	0.85
1.5 inch	0.87	0.77	0.80	0.94
2.0 inch	0.875	0.778	0.805	0.955
2.5 inch	0.86	0.785	0.81	0.97
3.5 inch[6]	0.85	0.80	0.82	1.00

[1] Values from *ASHRAE Handbook of Fundamentals*, 1993 edition, Chapter 24, Tables 1, 2 and 3 reprinted in Appendix B of this manual.

[2] Assumes a non-reflective surface emittance of 0.90 and winter heat flow direction.

[3] Use the "Flat" roof R-values for roof angles between horizontal and 22 degrees.

[4] Use the "45 degree" roof R-values for roof angles between 23 and 60 degrees.

[5] Assumes mean temperature of 90ºF, temperature difference of 10ºF, surface emittance of 0.82 and winter heat flow direction.

[6] Use these R-values for air spaces greater than or equal to 3.5 inches, such as attics.

Table G-8: DEFAULT SOLAR HEAT GAIN COEFFICIENT

Frame Type	Product	Glazing	Total Window SHGC Single Pane	Total Window SHGC Double Pane
Metal	Operable	Uncoated	0.80	0.70
Metal	Fixed	Uncoated	0.83	0.73
Metal	Operable	Tinted	0.67	0.59
Metal	Fixed	Tinted	0.68	0.60
Metal, Thermal Break	Operable	Uncoated	0.72	0.63
Metal, Thermal Break	Fixed	Uncoated	0.78	0.69
Metal, Thermal Break	Operable	Tinted	0.60	0.53
Metal, Thermal Break	Fixed	Tinted	0.65	0.57
Non-Metal	Operable	Uncoated	0.74	0.65
Non-Metal	Fixed	Uncoated	0.76	0.67
Non-Metal	Operable	Tinted	0.60	0.53
Non-Metal	Fixed	Tinted	0.63	0.55

SHGC = Solar Heat Gain Coefficient

Table G-9: SHGC's FOR ALLOWED INTERIOR SHADING ATTACHMENTS[1]

Interior Shading Attachment/Device	SHGC Before Jan. 1, 2002	SHGC On or After Jan. 1, 2002
Standard *includes Draperies (all colors & weaves), None (for non-skylights),or Translucent Roller Shades (all colors) Standard* values are also used for any interior shading device not otherwise listed in this table.	0.68	0.68
Blinds *All Colors of Venetian Blinds, Miniblinds, or Vertical Blinds.*	0.47	0.47
OpRollShd Opaque Roller Shades (All Colors)	0.47	0.47
None Only Allowed for Skylights. Also the default value for skylights when no other interior shading is specified.	1.00	1.00

[1] Shading devices between glazing lights for vertical windows or skylights may be modeled as an interior shading device or interior shading attachment of the same type.

Table G-10: Solar Heat Gain Coefficients Used for Form S and Computer Performance Methods [1,2]

Exterior Shading Attachment/Device[3]	SHGC[4]
1) Standard Bug Screens	0.76
2) Exterior Sunscreens with weave 53*16/inch	0.30
3) Louvered Sunscreens w/louvers as wide as openings	0.27
4) Low Sun Angle (LSA) Louvered Sunscreens	0.13
5) Roll-down Awning	0.13
6) Roll Down Blinds or Slats	0.13
7) None (for skylights only)	1.00

1. These values may be used on line 11 of the Solar Heat Gain Coefficient Worksheet (form S) to calculate exterior shading with other glazing types and combined interior and exterior shading with glazing.

2. Exterior operable awnings (canvas, plastic or metal), except those that roll vertically down and cover the entire window, should be treated as overhangs for purposes of compliance with the Standards.

3. Standard bug screens must be assumed for all fenestration unless replaced by other exterior shade screens. The solar heat gain coefficient listed for bug screens is an area-weighted value that assumes that the screens are only on operable windows. The solar heat gain coefficient of any other exterior shade screens applied only to some window areas must be area-weighted with the solar heat gain coefficient of standard bug screens for all other glazing (see Weighted Averaging in the Glossary). Different shading conditions may also be modeled explicitly in the computer performance method.

5. Reference glass for determining solar heat gain coefficients is 1/8 inch double strength (DSS) glass.

Table G-11: Source Energy Conversion Rates[1]

Energy Source	Btu per unit consumption
Electricity	10,239 Btu/kilowatt-hour
Natural Gas	100,000 Btu/therm
Fuel Oil	138,400 Btu/gallon
LPG (Propane)	91,080 Btu/gallon

[1] Reprinted from EES, Section 102, Table 1-B.

Table G-12: Thermal Mass Properties

Material	Conductivity (Btu/hr-ft^2-°F)	Density (lb/ft^3)	Specific Heat (Btu/lb-°F)
Adobe	**0.33**	**120**	**0.20**
Heavy Concrete	**0.98**	**140**	**0.20**
Lightweight Concrete	**0.36**	**85**	**0.20**
Gypsum	**0.09**	**50**	**0.26**
Masonry Veneer	**0.62**	**127**	**0.20**
Masonry Infill	**0.44**	**120**	**0.20**
Concrete Masonry Unit	**0.59**	**105**	**0.20**
Grouted Concrete Masonry Unit	**1.00**	**134**	**0.20**
Stucco	**0.47**	**105**	**0.20**
Tile in Mortar	**0.67**	**120**	**0.20**
Solid Wood (Fir)	**0.07**	**32**	**0.33**

Table G-13: Thermal Mass Coverings and Associated Categories[1]

Category 1: Acceptable as Exposed Mass In Any Location. Floor coverings/surfaces determined to be acceptable on any portion of a slab designated as thermal mass in any location within the conditioned space of a residential building.

Category 2: Acceptable as Exposed Mass Only In Kitchens, Dining Areas that are Extensions to Kitchens, Pantries, Bathrooms, Laundry Rooms, Service Porches and/or Entries. Concrete slabs with Category 2 surfaces must be treated as covered slab in other locations.

Covering/Surface	Category
Brick	1
Concrete, Exposed Aggregate	1
Concrete, Painted and/or Polished	2
Concrete, Stamped	1
Concrete, Unfinished	2
Hardwood Veneer (except when installed on wood sleepers)	1
Resin-based Poured Flooring	2
Stone or Stone Veneer	1
Sheet Vinyl	2
Tile, Asphalt	2
Tile, Ceramic	1
Tile, Terrazzo	1
Tile, Vinyl	2
Tile, Vinyl-Asbestos	2
Other Masonry Materials with Permanent Finishes Similar to Those Specified in Category 1 and Acceptable to the Building Official	1

1. The intent of these guidelines is to prevent taking exposed thermal mass credit for floor materials that are likely to be covered with carpeting at the time of building occupancy.

   Building officials should allow flexibility for building designs that include radiant floor heating systems and/or that incorporate large areas of uncarpeted slabs in conjunction with south facing glazing as an integral component of deliberately designed passive solar structures.

Table G-14: Standard U-Values of Wood Frame Roofs and Ceilings[1]

Ceiling Insul.	Framing Spacing	Reference Name[2]	U-Value
R-0[3]	16" o.c.	R.0.2X6.16	0.298
R-0[3]	24" o.c.	R.0.2X4.24[4]	0.306
R-11[3]	16" o.c.	R.11.2X6.16	0.077
R-11[3]	24" o.c.	R.11.2X4.24	0.077
R-13[3]	16" o.c.	R.13.2X6.16	0.069
R-13[3]	24" o.c.	R.13.2X4.24	0.069
R-19	16" o.c.	R.19.2X8.16	0.051
R-19	24" o.c.	R.19.2X4.24	0.047
R-22	16" o.c.	R.22.2X10.16	0.045
R-22	24" o.c.	R.22.2X4.24	0.041
R-30	16" o.c.	R.30.2X10.16	0.036
R-30	16" o.c.	R.30.2X12.16	0.034
R-30	24" o.c.	R.30.2X4.24	0.031
R-38	16" o.c.	R.38.2X12.16	0.030
R-38	16" o.c.	R.38.2X14.16	0.028
R-38	24" o.c.	R.38.2X4.24	0.024
R-49	16" o.c.	R.49.2X4.16	0.019
R-49	24" o.c.	R.49.2X4.24	0.019

1. Based on ASHRAE Parallel Heat Flow Calculation, 1993 *ASHRAE Handbook of Fundamentals*.
2. The names given to the standard assemblies used to calculate these U-values in Appendix H.
3. Does not meet the minimum level required as a mandatory measure (see Chapter 2, Part 2.2).
4. Roof/ceiling assemblies whose reference names list 2X4 framing include an attic space.

Table G-15: Standard U-Values of Wood Frame Walls[1]

Insul.	Wall Spacing	Framing Name[2]	Reference U-Value
R-0[3]	16" o.c.	W.0.2X4.16	0.385
R-0[3]	24" o.c.	W.0.2X4.24	0.393
R-7[3]	16" o.c.	W.7.2X4.16	0.130
R-7[3]	24" o.c.	W.7.2X4.24	0.127
R-11[3]	16" o.c.	W.11.2X4.16	0.098
R-11[3]	24" o.c.	W.11.2X4.24	0.094
R-13	16" o.c.	W.13.2X4.16	0.088
R-13	24" o.c.	W.13.2X4.24	0.085
R-15	16" o.c.	W.15.2X4.16	0.081
R-15	24" o.c.	W.15.2X4.24	0.077
R-19	16" o.c.	W.19.2X6.16	0.065
R-19	24" o.c.	W.19.2X6.24	0.063
R-21	16" o.c.	W.21.2X6.16	0.059
R-21	24" o.c.	W.21.2X6.24	0.056
R-25	16" o.c.	W.25.2X6.16	0.046
R-29	16" o.c.	W.29.2X4.16	0.035
Solid core wood door (no insulation)		D.O.SCW	0.330

1. Based on ASHRAE Parallel Heat Flow Calculation, 1993 *ASHRAE Handbook of Fundamentals*.
2. The names given to the standard assemblies used to calculate these U-values in Appendix H.
3. Does not meet the minimum level required as a mandatory measure (see Chapter 2, Part 2.2).

Table G-16: Standard U-Values of Wood Frame Raised Floors[1]

Floor Insul.	Condition	Reference Name[2]	U-Value
R-0[3]	No C.S.4	FXO.2X6.16	0.241
R-0[3]	With C.S.[4]	FC0.2X6.16	0.097
R-11[3]	No C.S.	FX11.2X6.16	0.071
R-11[3]	With C.S.	FC11.2X6.16	0.050
R-13	No C.S.	FX13.2X6.16	0.064
R-13	With C.S.	FC13.2X6.16	0.046
R-19	No C.S.	FX19.2X8.16	0.049
R-19	With C.S.	FC19.2X8.16	0.037
R-21	No C.S.	FX21.2X8.16	0.045
R-21	With C.S.	FC21.2X8.16	0.035
R-30	No C.S.	FX30.2X10.16	0.034
R-30	With C.S.	FC30.2X10.16	0.028

1. Based on ASHRAE Parallel Heat Flow Calculation, 1993 *ASHRAE Handbook of Fundamentals*.
2. The names given to the standard assemblies used to calculate these U-values in Appendix H.
3. Does not meet the minimum level required as a mandatory measure (see Chapter 2, Part 2.2).
4. No C.S. = No Crawl Space, With C.S. = With Crawl Space

Table G-17: Standard U-Values of Wood Foam Panel Roofs/Ceilings and Walls[1]

Roof/ Ceiling Insul.	Framing Spacing	Reference Name[2]	U-Value
R-14[3]	48" o.c.	RP.14.2X4.48	0.058
R-22	48" o.c.	RP.22.2X6.48	0.041
R-28	48" o.c.	RP.28.2X8.48	0.033
R-35	48" o.c.	RP.35.2X10.48	0.027
Wall Insul.	**Framing Spacing**	**Reference Name**	**U-Value**
R-14	48" o.c.	WP.14.2X4.48	0.062
R-22	48" o.c.	WP.22.2X6.48	0.044

1. Based on ASHRAE Parallel Heat Flow Calculation, 1993 *ASHRAE Handbook of Fundamentals*.
2. The names given to the standard assemblies used to calculate these U-values in Appendix H.
3. Does not meet the minimum level required as a mandatory measure (see Chapter 2, Part 2.2).

Table G-18: U-Values of Steel Frame Walls[1]

Wall Insul.	Framing Type	Framing Spacing	Reference Name[2]	U-Value[3]
R-11[3]	2x4	16" o.c.	W.11.S2X4.16	0.202
R-11[3]	2x4	24" o.c.	W.11.S2X4.24	0.173
R-13[3]	2x4	16" o.c.	W.13.S2X4.16	0.195
R-13[3]	2x4	24" o.c.	W.13.S2X4.24	0.165
R-15[3]	2x4	16" o.c.	W.15.S2X4.16	0.189
R-15[3]	2x4	24" o.c.	W.15.S2X4.24	0.158
R-19[3]	2x6	16" o.c.	W.19.S2X6.16	0.162
R-19[3]	2x6	24" o.c.	W.19.S2X6.24	0.135
R-21[3]	2x6	16" o.c.	W.21.S2X6.16	0.157
R-21[3]	2x6	24" o.c.	W.21.S2X6.24	0.130
R-22[3]	2x6	16" o.c.	W.21.S2X6.16	0.158
R-22[3]	2x6	24" o.c.	W.21.S2X6.24	0.132

1. Based on ASHRAE Zone Method Calculation, 1993 *ASHRAE Handbook of Fundamentals*.
2. The names given to the standard assemblies used to calculate these U-values in Appendix H.
3. Does not meet the minimum level required as a mandatory measure (see Chapter 2, Part 2.2).